The Australian and New Zealand Journal of Surgery

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THE AUSTRALIAN AND NEW ZEALAND JOURNAL OF SURGERY

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THE IMMEDIATE TREATMENT OF THE BURNED PATIENT.[1]

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IT is proposed that the treatment of burns should be considered under the following headings: (i) The immediate treatment of the burned patient. (ii) The treatment of the wounds resulting from the destruction of the skin by burning. (iii) The treatment of the skin defects resulting from the burn.

Much confusion seems to have resulted from the failure to give these phases of burn treatment their proper value. It must be recognized that the burn produces in the patient a syndrome characterized by both local and systemic effects. The effects upon the cutaneous covering of the body are obvious, but the systemic effects are more difficult to assess.

To adopt a method of treatment which may be satisfactory for certain wounds but which neglects the systemic effects of the burn seems illogical, yet medical literature abounds with descriptions of such methods. It seems unsound to advocate a method of treatment which will inhibit bacterial growth or one which will stimulate epidermal proliferation, if the systemic effects of the burn cause death of the patient before bacterial growth can occur and before epidermal proliferation has commenced.

For the purposes of the present discussion the author will limit himself mainly to the immediate treatment of the burn, while Major Rank will consider in detail the later phases of wound treatment and repair of the skin defects. For the sake of completeness the author has added some notes upon wound treatment which may be pertinent to the discussion.

The constant pathological changes shown at necropsy in the patient who dies from the effect of burns are few. Apart from the obvious destruction of tissue by the burning agent, there occur marked central necrosis of the liver lobules, general visceral passive congestion and œdema of the renal tubules. There occur occasionally gastro-intestinal ulcerations (usually in the duodenum) and hæmorrhagic necrosis of the suprarenal cortex. The author has described instances of sudden death on the third to fifth days from cardiac collapse preceded by arrhythmia, somewhat resembling the cardiac effects from diphtheria toxin upon the heart, but no lesion of the heart has been recognized at necropsy.

Immediately after receipt of the burn there takes place a rapid exudation of plasma-like fluid from the blood stream into the vesicles and blebs at the site of the burn and into the subcutaneous tissues beneath the site of the burn. In extensive burns generalized œdema may occur. This exudation of

[1] This paper was read at a symposium on "Burns" held at the Royal Australasian College of Surgeons on June 12, 1942. Accepted for publication on July 2, 1942.

fluid, which is apparently caused by increased capillary permeability, results in loss of plasma protein, salt and fluid from the blood stream, and this loss is followed by cellular concentration and relative increase in nitrogenous products. The cause of the increased capillary permeability is not entirely understood. A tenable explanation is that local injury to the capillaries at the site of the burn results in rapid local outpouring of fluid from the blood stream, causing immediate blood concentration of slight degree. Unless compensation is quickly made for this change, blood volume may be reduced enough to produce tissue anoxia which in turn leads to a generalized increased capillary permeability. A vicious circle is thus established which permits more plasma-like fluid to leave the blood stream. (See the work of Underhill and his associates, Harkins, Bialock, Wilson and their associates, Martin, Keeley and their associates, and Scudder.)

Experimental work by Davidson, Wilson and associates, Rosenthal, Bernhard-Kreis, and others has suggested that a toxic substance may be formed at the site of the burn. This has been described by some as the "H-substance" because of the similarity in behaviour of burned animals to those injected with toxic doses of histamine. Loss of sodium ion into the burned site has been described by Wilson and by Scudder, who suggest that the increase in the blood potassium content may be the "toxic factor".

From the clinical standpoint it is difficult to explain the behaviour of the burned patient upon the basis of physical phenomena alone. While most severely burned patients manifest the physical changes described, an occasional patient will die without evidence of what may be termed secondary shock, and with what seems more like an overwhelming toxæmia. The rapidity of plasma shift and its return to normal are also difficult to explain upon physical changes alone. It must be stated, however, that at the present time experimental evidence favours the physical theory of burn effects.

Aldrich and Firor have stressed the importance of bacterial growth and toxin production as a factor in the systemic reaction and as a cause of death due to severe burns. Their hypothesis has not, however, seemed consistent with the fact that in the majority of fatal burns the patients die within the first twenty-four hours, as shown in previous reports of the author and in those of Beekman.

Upon theoretical grounds, therefore, it seems reasonable to assume that the coagulation régime meets the requirements for primary treatment. There is also statistical evidence previously reported which seems to support the value of the regimen. Table I and Figure I show the reduction in mortality

TABLE I.

Comparative Mortality—Burn Treatment.

Name of Author.	Other Methods.		Coagulation Régime.	
	Number of Patients.	Percentage Mortality.	Number of Patients.	Percentage Mortality.
Bancroft and Rogers (New York) ..	90	40·0	114	20·0
Beekman (New York)	320	37·8	632	8·5
Wilson (Edinburgh)	300	38·7	117	11·1
Harris (Toronto)	—	26·6	—	12·0
Mason (Philadelphia)	91	28·5	87	13·3
Langer (Vienna)	86	16·3	65	7·7
Mitchiner (London)	243	9·4	249	2·4
McClure and Allen (Detroit)	118	9·3	358	11·7
Glover (Cleveland)	121	14·0	894	7·8
Total number of patients ..	1,369	—	2,516	—
Average mortality	—	24·5	—	9·2

reported from various clinics. While it is difficult to determine the differences in the mortality rates from the individual clinics, in the aggregate the difference appears to be significant. No statistical reports are available showing the results of treatment with the paraffin spray, saline or soap baths, the Bunyan envelope, oils or ointments, concerning which there are many reports in the literature. There is likewise no conclusive experimental or clinical evidence, with which the author is familiar, that any of these methods significantly affect fluid loss or plasma shift, although some of them may limit bacterial contamination. Until such statistical and experimental evidence is available, the burden of proof rests with the advocates of other methods of treatment.

Among the commoner coagulating agents which have been used are: tannic acid (Davidson), tannic acid and silver nitrate (Bettmann), gentian

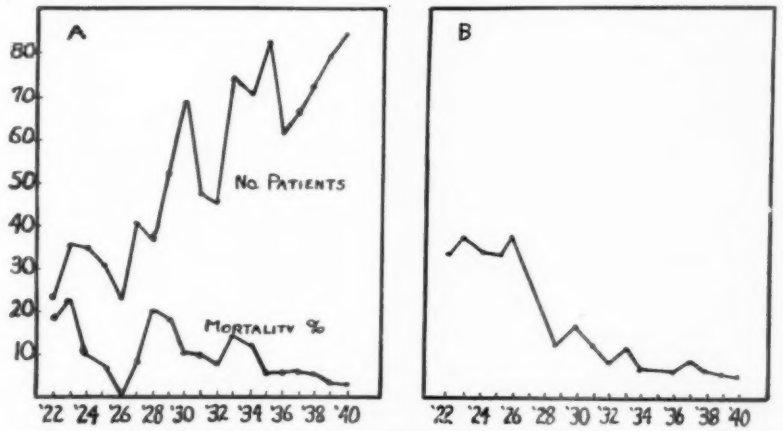

FIGURE I. Two continuous charts of burn mortality. Chart A shows the mortality curve on the author's burn service, Saint Luke's Hospital, Cleveland, from 1922 to 1940 inclusive. Chart B shows the mortality curve from Penberthy's series, Detroit, during the same interval of time. In both series the coagulation régime was begun in 1926, tannic acid being used alone at first; silver nitrate was added in 1935. During 1939 the use of blood plasma and suprarenal cortical extract was begun. An almost identical mortality trend was noted by Beekman, of New York. It will be observed that any effort to draw conclusions from any single year or from any small number of patients would be misleading.

violet, "triple dye" (Aldrich), ferric chloride (Coan), sulphadiazine (Pickrell), and the natural coagulum formed on the surface of a burn beneath a voluminous dry gauze dressing (Allen). Each has been advocated upon the basis of certain specific advantages. There seems to be general agreement that of them all the combination of tannic acid and silver nitrate most quickly forms a coagulum, with the combination of aniline dyes probably next in order. The author's experience with sulphadiazine has been very slight, but it is possible that its bacteriostatic properties may compensate partly for slow coagulation. Upon the basis of speed of coagulation, since there seems to be a definite relationship between speed of coagulation and control of plasma shift, the author's preference is for tannic acid and silver nitrate.

THE MANAGEMENT OF A SEVERE BURN BY THE COAGULATION RÉGIME.

The following is an outline of management of a severe burn by the coagulation régime. It must be understood at the outset that organization

and teamwork in the hospital are essential to effective management of the burned patient, who should be given preference and whose condition should be regarded as an emergency. Enough personnel should be mobilized for prompt and complete care at the first instant. A burn cart, with the contents enumerated below, kept ready in the central supply room, has been found to be a great help in providing prompt treatment.

Contents of Burn Cart.

The contents of the burn cart are as follows:

Two electrical outlets with connecting cord and plug.
Electric hair drier.
Spray bottle for tannic acid spray, preferably small paint spray bottle with motor pump or foot bellows.
Six bottles of about eight ounces, each containing enough tannic acid powder to make 10% solution when water is added.
Two bottles of 10% silver nitrate solution.
Jar of tannic acid jelly.
Four sterile sheets.
Six packages of sterile towels.
Six packages of sterile gloves, two pairs each of size 7, 7½ and 8.
Two packs of sterile instruments, each containing one pair of pick-up forceps, two hæmostats and one pair of sterile scissors.
Dressing can of sterile gauze.
Dressing can of sterile cotton balls.
Roll of adhesive plaster.
Can of ether for cleansing.
Green soap.
Two sterile basins.
One emesis basin.
One large basin for contaminated dressings.
One sponge forceps in container with alcohol or cresol.
"Luer", "Triumph" or "Asepto" syringe for flushing surface with saline solution.
Jar of sterile "Vaseline".
Arm board, padded.
Six two-inch bandages.
Two intravenous sets with needles.
Intravenous solutions: physiological salt solution, 5% dextrose in salt solution, plasma (obtained from pharmacy when cart is called out).
Blood pressure apparatus.
Hypodermic syringe.
Suprarenal cortical extract or desoxycorticosterone acetate (ampoules).
Boric acid solutions in eye irrigator.
Dropper bottle with sterile castor oil.
Sterile eye pads.

Additional Burn Tray (for Dakin's Dressings).

For Dakin's dressings an additional burn tray with the following contents is provided.

Six large sterile gauze rolls (full width bolt gauze folded to make rolls roughly five inches by five yards).
Salt solution.
Dakin's solution (surgical hypochlorite solution).
Sterile petrolatum and petrolatum gauze.
One-pound roll of absorbent cotton (sterile, wrapped).
Six three-inch gauze bandages.
Oiled silk, rubber dam, oiled paper or "Cellophane", for covering dressings.
Pack of sterile instruments, including one tissue forceps, hæmostat, and sterile scissors.
Bandage scissors.

First Aid.

If hospital facilities are available within an hour or two, wrap the patient in blankets, keep him warm, give morphine, and send him immediately to the hospital, without removing his burned clothing. If transportation is

to be delayed, remove his clothing, apply tannic acid jelly to the burned surface, cover it with gauze and bandages, treat shock with blood plasma or serum given intravenously, give morphine as indicated, keep the patient warm, and transport him to hospital as soon as possible.

Hospital Treatment.

1. After removing his clothing, put the patient in bed at once on a sterile sheet, beneath a lighted cradle in which a temperature of 36° C. to 38° C. is maintained, with bedclothes over the cradle. The cradle should be large enough to cover the entire bed for an extensive burn.

2. Give morphine if indicated.

3. Cleanse the burned surface quickly and gently without anæsthesia. (If treatment has been delayed for many hours, *débridement* may be painful enough to require brief anæsthesia with "Pentothal Sodium" or "Avertin".) If grease had been used upon the burned surface prior to the patient's admission to hospital, remove the grease with benzine or ether or ether soap; scrub gently with soap and water and flush with salt solution. Open all blebs and blisters and peel off all dead epidermis, using sterile instruments. The operator should wear sterile gloves and wear a mask over nose and mouth. If the burn is extensive, several operators should work together during this *débridement* and tanning, in order to minimize the time required and the discomfort and shock to the patient.

4. Tannic acid (10% aqueous solution) is then sprayed with an atomizer or small spray pump over the burned surface. This is continued until a whitish coagulum forms, followed by a brownish coagulum. When the latter stage is reached, which usually takes about twenty minutes, the surface is ready for the next stage.

5. The next stage consists of a relatively painless application of silver nitrate (10% solution) with large applicators. If the application of silver nitrate is attempted before the tannic acid coagulum has begun to form it will be painful. After the silver nitrate has been applied, a dark, purplish-brown coagulum will be formed within about ten minutes. From this time on the patient should be fairly comfortable.

6. If additional blisters or blebs form, they should be treated in a similar manner.

7. Use petrolatum to muco-cutaneous junctions, if indicated, to prevent drying and cracking.

8. Upon the face tannic acid jelly (5% tannic acid incorporated in a tragacanth base, preferably about the consistency of lubricating jelly) is used; it is applied to the burned surface with an applicator or sterile tongue blade. No dressing is applied over the tannic jelly. (Tannic acid and silver nitrate may be used on the face, if care is taken to prevent injuring the eyes.) If tannic acid and silver nitrate are not available, or if it is desired to make the patient ambulatory, tannic jelly may be used and covered with an ordinary sterile dressing. Or, if desired for ambulatory care, the tannic acid and silver nitrate coagulum may be produced as noted above; when it is thoroughly dry it may be encased in a sterile dry dressing or sterile towel.

9. A motor hair drier will greatly facilitate the drying of the coagulum.

10. Daily estimations of hæmoglobin, hæmatocrit readings, red cell count and examinations of the urine should be made at least on the first four days. Where burns are extensive, estimations should be made oftener.

11. If the burn is extensive, start an intravenous drip of blood plasma or serum while the *débridement* process is going on. If the burn is not extensive and the patient is not nauseated, the administration of plasma may be delayed until laboratory examinations have been made and the patient has

had time to become stabilized after the tanning. If plasma is not available, give dextrose and saline solution intravenously by the slow drip method. Except when larger quantities of plasma are required to control blood concentration, the daily fluid intake should not be over 3,000 cubic centimetres for the first three days. In a burn involving a very great surface area, several litres of plasma may be required during the first two or three days to control plasma shift and blood concentration.

12. If available, suprarenal cortical extract or desoxycorticosterone acetate may be used to lessen shock and plasma shift. In severe burns it may be given every one, two or four hours, as required, to help keep the patient out of the shock level. (It is the author's impression that less plasma is required where one of these preparations is used.)

Later Treatment: Dakin's Dressings.

If the burn is superficial, the temperature will remain normal and at the end of about a week or ten days the coagulum will peel off, leaving a practically intact epidermis.

If the burn is deep, by the end of the first week the temperature will be elevated, and the crust will show signs of "floating" and cracking, or will show exudate about the edges. Continuous Dakin's solution dressings are then applied as follows:

1. Normal skin is greased with sterile petrolatum or covered with petrolatum gauze.

2. Heavy gauze rollers wet with Dakin's solution are wrapped about the crusted area and covered with a thick layer of sterile absorbent cotton (about one-half the thickness of the cotton sheet as it comes in the one-pound roll), also wet with Dakin's solution and bandaged on snugly. A sheet of oiled silk, rubber, oiled paper, or "Cellophane" is then bandaged over all securely to keep the solution from evaporating.

3. The outer covering is removed, and the dressing is remoistened with Dakin's solution and rebandaged every four hours, to insure a continuous Dakin effect. (The Dakin's solution must not be over three days old and must be a solution known to have the prescribed available chlorine content.)

4. Dressings are changed once a day, and the coagulum is lifted off or trimmed off with sterile scissors as it separates. This process may require from three days to three weeks, depending upon the depth of the burn and its extent.

5. If Dakin's dressings have to be continued for several weeks, they may become painful. This is helped by using strips of "Vaseline" or petrolatum gauze partly covering the granulations beneath the Dakin's dressing, or by changing to salt solution dressings for a day or so. It will occasionally be noted that when Dakin's dressings are first applied a sharp temperature rise will occur. This seldom lasts more than a few hours, and is probably due to the softening of the coagulum, with absorption that results from the softening, before the Dakin's solution has thoroughly saturated the underlying exudate. It is not a matter for concern.

6. If when coagulum is all off and the granulating wound is clean, (*a*) there are many epidermal islands which will cause quick healing, wet dressings or simple boric ointment may be used until healing is complete; (*b*) there are no islands, or so few that more than three weeks will be required for complete healing, skin grafting should be done without delay.

Prompt skin grafting will prevent: (*a*) delayed convalescence, (*b*) secondary septic complications which may be fatal, (*c*) disabling and disfiguring scars and contractures, (*d*) Marjolin's ulcer (carcinoma in the scar).

Split thickness (sometimes called Thiersch) grafts are the most effective for covering large surfaces quickly with satisfactory skin. When tendency to contract is great, or in special locations, free full thickness grafts, pedicled flaps or Esser inlay grafts should be used. Small deep grafts (often called pin-point or Reverdin grafts) have a very limited field of usefulness, because they permanently deform the donor site and produce skin on the recipient area of poor quality with masses of scar between the islands of grafted skin.

COMMENT UPON THE COAGULATION RÉGIME.

Anæsthesia.

Anæsthesia is to be avoided during the *débridement* and coagulation process if possible, since it produces an additional factor of shock. It is unnecessary if treatment is carried out promptly and expeditiously.

Débridement and Cleansing.

The process of *débridement* and cleansing should be simple, rapid and without trauma. Elaborate scrubbing is unnecessary and shock-producing. If it is necessary to choose between thorough cleansing and avoidance of additional shock, the latter is the better choice. The infective complications are almost non-existent if a systematic régime of coagulation as described is carried out. The coagulum will even encapsulate gross particles of dirt without incident; but it is of course preferable to leave no contaminated particles in the field.

Control of Plasma Shift and Maintenance of Fluid Balance.

Blood plasma (or serum) is the ideal colloidal solution to replace the plasma which is lost from the blood stream. Given a severe burn, the first intravenous injection of blood plasma should be started as soon as the patient is in bed, without waiting for laboratory data. Subsequent amounts will be governed by the evidence of shock and blood concentration. The hæmatocrit reading is probably the most useful guide, but the red cell count is almost as reliable. Determination of the plasma protein level of the blood is theoretically the most reliable guide to replacement therapy, but its determination even by the simplest methods is more cumbersome. In the author's experience, the use of the plasma protein level as the index may lead to the giving of unnecessarily large amounts of plasma, owing apparently to the lag in bringing the protein level up to normal. Of the three methods the red cell count is the simplest and quickest, and seems to be almost as accurate as the hæmatocrit estimation (see the charts in Figure II). In the face of shortage of standard hæmatocrit tubes, Lieutenant-Colonel J. M. Hayman, junior, and Lieutenant F. A. Rose, of the Medical Service, devised from simple laboratory tubing an apparatus which has proved quick and accurate in the hæmatocrit estimation. This apparatus has been described by them in a separate publication.

Several formulæ have been devised for calculating the needed volume of blood plasma (Elkinton, Wolff and Lee), but the simple rule of thumb proposed by Harkins has been found practical; that is, the addition of 100 cubic centimetres of plasma for every point that the hæmatocrit reading is elevated over the normal (47 by the technique of Hayman and Rose). The same rule may be applied also by the addition of 100 cubic centimetres of plasma for each 100,000 cells above the normal in the red cell count. The total amount to be used during the early days of the burn has been subject to much discussion, but it is the opinion of the author that no more than three litres of fluid of all kinds should be given per day to the severely burned

adult during the first three days. Between one and two litres of plasma a day for the first three days will usually be adequate in a burn near the lethal limit. During this interval there is marked diminution in the urine output, as shown in the diagrams, and it is futile to give the patient an excess of fluid which immediately leaks out of the blood stream. Plasma remains in the blood stream longer than does a solution of crystalloids, but during the period of increased capillary permeability even plasma is rapidly lost. It is therefore futile to administer large quantities of any kind of fluid until the capillaries have recovered their ability to hold fluid and the kidneys are able to excrete it. During this stage the patient is often desperately thirsty, but is unable to retain water taken by mouth.

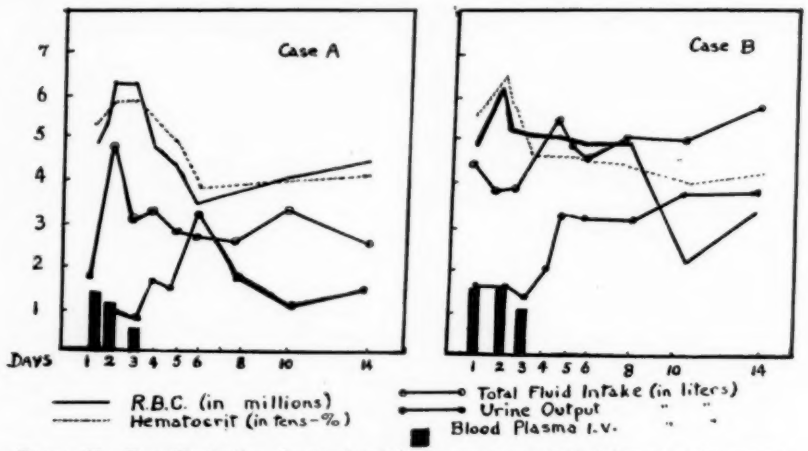

FIGURE II. Two illustrative charts showing the course of fluid balance in the severe burn. It will be noted that the hæmatocrit and the red cell count approximate each other closely enough, so that either may be used safely as an index of plasma loss in determining the amount of blood plasma or serum to be administered. The urine output is low during the first three days, during the period of marked capillary permeability and œdema of the renal tubules. The output then increases as the capillary permeability becomes less and as the tissue œdema fluid is picked up and excreted. In Case A on the sixth day the urine output exceeded the fluid intake. In Case B the patient was still getting rid of œdema fluid at the end of two weeks.

Suprarenal cortical extract and desoxycorticosterone acetate have proved useful in maintaining the patient out of shock level during this critical period also. Wilson and Stewart, Wilson, Rowley and Gray, and Einhauser reported experimental and clinical evidence to indicate the beneficial effect of suprarenal cortical extract, and more recently clinical results are reported by Dennison and Devine, and Oldfield. The author has been impressed with the fact that desoxycorticosterone acetate has not only been of appreciable help in the treatment of burn shock, but has also apparently spared plasma, patients keeping in a better state of hydration with less plasma. The product has been used in five milligramme doses, given as often as every hour for several hours; but usually it is given only every four hours. Using the cortical extract, Rhoads, Wolff and Lee showed graphically the more rapid return to normal of plasma volume with blood plasma and extract than with plasma alone. No untoward effects have been observed.

Transfusion of Whole Blood.

Transfusions of whole blood are not indicated during the acute stage of the burn when cellular concentration already exists, but later in the course

of a severe burn the patient often develops a secondary anæmia. Then transfusion is clearly indicated.

Removal of the Coagulum.

The method described has been found most efficacious in removing the coagulum and keeping the granulating surface clean. Others prefer saline baths or surgical excision for this purpose. The coagulum has served its purpose during the first few days after the burn. When exudate begins to form beneath, it becomes a menace. Culture methods reveal that under constant Dakin's solution dressings, as described, appreciable bacterial growth seldom occurs. Keeping the surface rigidly clean at this stage may determine the final outcome. A clean wound heals quickly or becomes ready to graft early. The rapidity of healing is the chief determining factor in the functional and cosmetic outcome of burns of the extremities or face. With effective continuous Dakin's dressings the deep burn is usually ready to skin graft within a month.

Does the Coagulation Régime Injure the Skin of the Hands and Face?

It has been the contention of Wakeley, McIndoe, Oldfield, Taylor and others that tannic acid should not be used upon the face or hands because scarring is produced by the destructive effect of the coagulant and because the "encircling" coagulum may produce gangrene of the finger tips. It is conceivable that misapplication of the coagulation régime or failure to keep the wound clean in the later stage may lead to destruction of epidermis by bacterial growth, but it is to be doubted whether this happens often, if ever, in the absence of gross infection. Wakeley and Oldfield have published photographs showing the apparently unfavourable effects of the coagulum upon the hands and face. One might, on the other hand, produce many illustrations showing no residual scarring whatever from burns of equal depth and extent that were treated by coagulation. The author has, furthermore, been called upon to do extensive plastic work upon apparently similar burns treated by saline baths, oils or ointments.

The fact of the matter is that it is the burning agent which produces the scar and not the coagulant used in treatment. The scar is directly proportional to the depth and extent of skin destruction, with the additional unpredictable factor of fibrous tissue response which is peculiar to the skin of some individuals, just as is occasionally found to be true in fibrosis of the lung following infection or adhesions following peritonitis. The difficulty in recognizing at the outset the depth of the burn is understood by all surgeons of experience. To generalize upon the basis of a certain form of treatment in a specific case is hazardous.

The author has attempted to observe critically for some years the effect of the coagulum upon burned and normal skin in man and in animals. The coagulum produced by an ordinary aqueous solution of tannic acid and silver nitrate does not penetrate deeply, and this may be readily demonstrated by microscopic section. In spite of the work of Seeger and of Fantus with more penetrating isotonic solutions of tannic acid, the author and his associates have found no need for deeper penetration. It is impractical and unnecessary to attempt to coagulate the full thickness of the skin. In third-degree burns the proteins of the skin down to and sometimes through the corium have been completely coagulated by the burning agent. The tannic acid and silver nitrate combination merely adds a film over this surface which is continuous with the coagulum over the surface of the surrounding areas which are not so deep, thus sealing the entire wound.

It has been independently observed by three surgeons who have reported the largest series of hospital burns in the United States of America that

the incidence of necessity for skin grafting after burns was less in the coagulated series of burns than in their previous series. The author's associate, Captain C. A. Hamann, has several times used the coagulum of tannic acid and silver nitrate to fix fresh Thiersch or split thickness grafts to the donor site. The grafts were merely tanned in position and left exposed, with no dressings whatever. The takes were complete in each instance. The grafts were thin enough, so that any destructive effect of coagulation would have caused necrosis in the graft.

Upon the question of the constricting effect of the coagulum upon fingers, the author and his associates have likewise been unable to find confirmation. Rather than cause ischæmia, the coagulum actually seems to limit œdema and favour circulation by gentle pressure, a principle well known to the plastic surgeon. When gangrene does occur the ischæmic necrosis is almost certainly due to the destructive effect of the burning agent.

One may well ask: "What does it matter? If there is any question about it, use coagulation therapy upon other regions, and use compresses or ointments upon the face and hands." The matter could be dismissed in that manner if one could estimate with accuracy burns which were no threat to life; but that is difficult, if not impossible. The chart in Figure II, A, illustrates the fact that a burn of face and hands alone may cause blood concentration of serious degree, even when the areas are tanned. If one adds to this degree of plasma loss by only a few *per centum*, he may approach closely the lethal limit which has been found to occur in laboratory animals. If one is to be consistent in treatment, he cannot rationally compromise the life of the patient. There is, furthermore, no doubt that to use the coagulation régime throughout is far simpler and less cumbersome both in the hospital and in the field. On the question of consistent treatment, the author published two parallel series from hospitals in the same city during the same five-year period from 1935 to 1939 inclusive. In Hospital A, where the burns had been consistently treated with the coagulation régime on a special service for some years, 362 burns were treated with a mortality of 4·4%. In Hospital B most of the treatment was by the coagulation method, but the treatment was often delayed and there was no consistent procedure followed. There 227 burns were treated with a mortality of 13·6%.

Special Types of Burns.

Small deep burns, usually from electricity or hot metal, can often be cleansed and excised at the outset.

Burns involving the eyelids will almost always be followed by sufficient œdema to close the lids. During the primary treatment it is well to flush out the conjunctival sac with boric acid and to instil a drop of sterile castor oil. The conjunctival sac should be kept clear of secretion by frequent irrigations and instillation of a mild antiseptic. The cornea is fortunately seldom damaged by fire burns.

Chemical burns are usually best treated immediately by flushing with large quantities of inert solution to dilute the chemical agent rapidly. Subsequent treatment is usually carried on along the lines described for burns of other origin. The high incidence of serious damage to the eye in chemical burns demands the attention of an ophthalmologist.

Use of Sulphonamides.

Various of the sulphonamides have been used with varying reports of success in primary burn treatment as well as in treatment of the granulating wound. Vidas and McEachern found that in an oily base sulphanilamide remained in the base and very little went into solution with tissue fluid.

This has been confirmed by the author, who believes that ointments of this type are of little more value than an ointment of the base alone. In powder form or in solution the drugs have been used in the primary treatment of the burn. The powder certainly does not form a firm coagulum, and the coagulum formed by a solution is very slow (note previous mention of sulphadiazine). There is danger in using the powder or solution upon a granulating surface without very frequent blood level determinations. Dangerously high levels have been observed. The evidence concerning their effectiveness upon infected granulating surfaces is still open to question. In cases in which frank sepsis exists, there is some rationale in using one of the drugs by mouth, but such infections can be controlled by Dakin's solution without the sulphonamides.

COMPLICATIONS.

Curling's ulcer (acute gastro-intestinal ulceration) was observed in a number of instances in the early years of the author's series and previously reported. One chronic Curling's ulcer came to gastric resection five years later. Hæmorrhage from Curling's ulcer led to death in two instances. The incidence of this complication, as well as that of cholangitis, retinitis, peripheral neuritis, thrombophlebitis and pulmonary embolus has been nil during the past few years since we have been treating plasma shift more effectively, and perhaps since the entire régime has been better organized.

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BURNS.[1]

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The treatment of burns is usually assessed in terms of lives saved; but I wish to speak of the ultimate functional results—that is, not in terms of life, but in terms of livelihood. A living dog may be better than a dead lion, but I believe that many burns, which never were a threat to life, have their optimal result jeopardized by treatment which is primarily based on its life-saving value and which, perhaps, has become a surgical habit.

At the beginning of this war, surface coagulation was the hall-mark of the treatment of all burns. It was only within the limits of the principle of coagulation that opinions and surgical fashions varied. In civil life this treatment was generally regarded as satisfactory.

Soon after the war began it became apparent that, though the lives of many burnt combatants were being saved, the end results, in terms of worthwhile function, were often disappointing and sometimes horrible. Numbers of burnt soldiers and airmen from Dunkirk and the air war over England sooner or later arrived at plastic surgery units. Most had been treated by tannic acid; its coagulum still present on some, on others separating to reveal large raw infected areas. Many of the patients with burns which had healed, or were still healing, had disabilities due primarily to the contraction of resultant scar. A large proportion of these contractures were complicated by secondary contractures or fixations of tendons or joints, in which case they were usually beyond effective help from any reconstructive programme. It seems that any scar which embarrasses the function of a joint is a potential cause of irreparable changes about that joint, unless function is early restored. In addition to the primary and secondary effects of scar, many disabilities can be attributed to complications of coagulation treatment, especially sepsis. Much malfunction can well be associated with that smell of infected tan which we all know.

Broken morale was a common feature. There is no more soul-upsetting sight than of men, who a few weeks previously had been daring young fighter pilots, now changed to physical and moral wrecks, nervous and weeping. No wonder, with their features often destroyed, their sight in jeopardy or gone, their hands or hand remnants often without even the functional capacity to feed themselves! Lives saved, but what of future livelihood? I impress this awful picture on you because it was essentially this which precipitated a strong reactionary school against wholesale coagulation treatment of burns.

Many find the extensive current literature on this controversy confusing. It is my endeavour to clarify the position by discussing: (*a*) Why the functional results are disappointing with routine coagulation treatment of wartime burns. (*b*) What alternative the reactionary school has to offer. (*c*) What application this has with the many variations of time and place where burnt patients must be treated at this present time.

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WHY THE POOR RESULTS FROM THE COAGULATION TREATMENT OF WARTIME BURNS?

There are four reasons.

1. There are burns of a type and severity with which we were, perhaps, not so familiar—severe burns in restricted and important regions of the body. The classical example is the airman's burn. A man, for the most part protected, is suddenly exposed to flame or intense dry heat (were it not for this protection he would often be dead). The burn is usually limited to the hands, especially the dorsum and fingers, and the face about its periphery—that is, forehead, eyebrows, cheeks and the neck. These limited burns may never have been a threat to life, but what disastrous functional consequences they may have! This predilection for face and hands is common in war burns—flash, bomb blast or petrol explosions all take their maximum effect on the exposed parts.

2. It does seem that with general improvement in the treatment of burn shock on the lines Major Glover has detailed, more lives are saved from extensive burns.

3. Patients with war burns are often not received for main hospital treatment under the usual civilian conditions of time. First-aid treatment is often necessary under haphazard conditions, and this is followed by a long or difficult evacuation period. For this reason sepsis is frequent. This is largely where coagulation treatment breaks down.

4. I dare to add that we were, perhaps, misinformed of the universal place of coagulation therapy for burns. We know of the big drop in the mortality from burns after Davidson (of the Henry Ford Hospital, Detroit) introduced tannic acid treatment in 1925. We must not lose sight of this fact. This remarkable improvement may, in itself, have been responsible for the misconception that coagulation was the be-all and end-all of burn treatment. Let us not forget also that due recognition of the importance of burn shock and its adequate treatment was also emphasized at this time. Perhaps coagulation received undue credit on this account. It is no destructive criticism then of the great achievement of coagulation treatment if it is reviewed in an endeavour to reconcile treatment with worthwhile function.

The functional prognosis of any burn depends on the region involved and on the healing time. The earlier a burn is healed, the better the function. Immobilization will be of shorter duration, there will be less fibrosis from the replacement of accumulative granulation tissue, and less fibrotic reaction to surface sepsis. Consider tanning from this important aspect of healing time. When I speak of tanning I mean coagulation in general, whether produced by tannic acid, silver nitrate or any combinations of coloured coagula.

The Effect of Tanning on the Spontaneous Healing of Burns in which Epithelial Destruction has not been Complete.

Burns in which epithelial destruction has not been complete, may cover wide areas, as typified by the extensive scald more common in civilian life. When used for these burns the tan may save life. It may even limit infection. Though some normal epithelial cells may be included in the coagulation or fixing process and so destroyed, the total destruction by burn and tissue fixation leaves ample regenerative skin for good spontaneous healing. With desquamation the tan lifts off to give the good results from this type of burn which have, perhaps, given tannic acid its firm adherents. Lesser extents of this type of burn, which never are a threat to life, also do well, but so they do with any clean method of treatment.

But what if the tan is complicated by sepsis? In the field this is very common. It may be argued that I now speak of the malapplication of a method of treatment. It is no criticism of the surgeons in Tobruk if I say that infection was the rule for most of the tanned burns. I think it means that the method they had to use broke down under the difficult local and evacuation conditions. Surgeon Rear-Admiral Wakeley says that it is true of this as of the last war that, for practical purposes, all war burns must be treated as septic.

Adequate cleansing may be impossible after a first-aid coagulant dressing has been applied. This is the cry of the casualty clearing station surgeons. Coagulation applied early to a cleansed burn no doubt has done much to preclude widespread secondary infection; but if time has passed, or conditions are such that the burn cannot be adequately cleaned, coagulation may have the disastrous effect of creating non-drained sepsis under tension, with a large area for septic absorption. They may produce disaster.

On the Hands.—Apart from the added risk of sepsis, an effective tan acts as a splint to the finger joints. Moreover, local œdema beneath an effective tan of the hands may cause fixation of tendons or circulatory embarrassment with even terminal necrosis of fingers. Œdema is an invariable sequence of a burn. (Surface loss of plasma-like fluid is only a small proportion of that which is lost to the circulation by its accumulation in tissue spaces as œdema.) When burns are not tanned one realizes what an important feature œdema is and, incidentally, how dramatically this œdema disappears with plasma infusion.

The maleffects of œdema beneath an inelastic tan are increased by sepsis. These effects explain hands such as one in which the joints and tendons are fixed by fibrous tissue organization of œdema and avascular necrosis of terminal phalanges or knuckles has occurred. The result is a malfixed and useless hand, from a burn which may never have been a threat to life and in which there was no real indication for an aggravating method of treatment. I know it is held that these maleffects are not a complication of treatment, but are due to the initial severity of the burns. They are seen too frequently and sometimes with only second-degree burns.

On the Face.—Coagulation of the face is unsatisfactory. The coagulum cracks with the necessary movement about the facial orifices and again is usually infected. Corneal ulceration may come early with disastrous consequences. The splinting effect of a tan about the lid predisposes to ulceration. A tan delays surgical intervention which may be indicated for an ectropion which develops rapidly.

If, then, extensive burns not involving total skin destruction are to be tanned, the face and hands, in addition to the flexure lines, should not be tanned. I know that with small localized areas of burns on the hand satisfactory results are demonstrated by tanning, but so severe are the results of tanning more extensive burns of the hands that it seems dangerous to compromise on this point.

What is the Effect of Tan on a Burn when the Full Thickness of Skin has been Destroyed?

If the skin is destroyed beyond its capacity for regeneration, there is no point in comparing methods of treatment. The best method is that which gives earliest epithelialization by secondary intention healing of small areas or by skin grafting of larger areas. Every week which passes before epithelialization is completed means so much more fibrosis to replace

accumulated granulation tissue, so much fibrotic reaction to sepsis, so much more deterioration of general condition and morale, and so will the functional result fall short of the ideal for that particular burn.

Much of the so-called keloid, so common with third-degree burns, is nothing more than hypertrophic scar. This is a monument to delayed slow secondary intention healing over accumulated granulation. It is characteristic of third-degree burns, when sepsis has delayed ordinary healing, or in large areas which should never have been left to secondary intention healing. It is a misbelief that epithelium proliferates normally on a purulent surface. Granulation and fibrous replacement do proceed well under these conditions, as is common observation under closed plaster. But there is minimal epithelial proliferation in a quagmire of pus, be it under closed plaster or infected tan. The result is healing by a maximum of scar production and wound contraction. When this type of malhealing is accomplished, irritability, instability and breakdown, possibly malignant changes, occur in the horrid scars which result.

As surrounding fibrosis and tension increase in an area, healing becomes slower and may be arrested altogether, to leave chronic unhealed areas.

These are to be regarded as avoidable complications of a burn. They can be forestalled by early skin grafting.

On burns with full skin destruction any surface application cannot reach all the affected area—a tan will not only delay natural separation of dead tissue, but it will delay the opportunity of clearing sepsis and of preparing for effective skin grafting. Separation of a coagulum from a third-degree burn is not accomplished easily; indeed it seems often to depend on infection. By the time the area can then be adequately prepared for skin grafting much damage is done.

From the aspect of function, then, the tanning of any third-degree burn is contraindicated. If it is necessary as an initial life saver it must be removed as soon as its life-saving function is accomplished. I do not know how various coagulating agents compare in their life-saving function; but from the active removal of many I know that a coagulum produced by the vital dyes is more easily removed than the more vicious coagulum of tannic acid.

For practical purposes, in order to use coagulation discriminately a careful diagnosis must be made of the degree of a burn. Is the skin capable of spontaneous regeneration, or is it not? Most burns of the dry heat type are mixed: heterogeneous areas, where the destruction extends to variable depths and where there are islands of live undestroyed epithelium, aggregates of live cells, maybe individual cells capable of proliferation. What is the effect of tissue coagulation or fixation on such areas? There must often be destruction of these islands or cells, so that mixed areas with a good prognosis for rapid spontaneous healing are converted to large homogeneous areas of complete skin destruction, only capable of secondary intention healing. There seems to be some analogy between the tanning process and the old antiseptic, which does as much harm as it does good. Again, what of an infected tan? Sepsis, especially streptococcal infection, means certain cell destruction and histolysis of those important cells left undestroyed by the initial burn.

Who is to make the important and difficult decision of the degree of a burn and which burn will not suffer unduly by tannic acid treatment? Not a first-aider!

It is not an easy clinical decision with a recent burn. It is an impossible decision with a burnt area which has already received a tannic acid type of first-aid dressing.

WHAT ALTERNATIVE IS THERE TO COAGULATION TREATMENT?

It was for burns of the third degree that the American plastic surgeons Blair and Barrett-Brown about ten years ago advocated with sound reasons the time-old treatment of saline baths. Without resort to tanning, this treatment relied on the natural separation of dead tissue and the preparation of the area in the shortest possible time for skin grafting. Saline baths are a routine in most plastic clinics for the preparation of any extensive granulating surface for skin. This was all before the use of plasma and serum in the treatment of shock.

McIndoe in England started the use of saline bath treatment for war burns. This was essentially for special types of war burns—those for which coagulation was so unsatisfactory.

Shock is treated by the usual means, with controlled use of plasma, as indicated. When shock is controlled, under general anæsthesia (or morphine amnesia for the less extensive burns) the areas are carefully and rapidly cleaned; this may require two operators. It may be a tedious process, with a blast burn, for example. Only pure soap and water and saline solution are used; every effort is made to avoid further damage. Such precipitants as ether or spirit are not used. The areas are not tanned, but are covered with *tulle gras,* a non-adherent and easily permeable material. On the *tulle gras* are placed wet saline gauze packs. These are changed or kept wet. As soon as the general condition permits saline baths are commenced. For periods up to two hours each day the patient or part is immersed in a saline bath. (McIndoe has an ingenious constant temperature, continuous saline bath which supplies normal saline at a definite rate at a controlled temperature.) Dressings are allowed to float off in the bath, any débris is removed from the burnt areas and movement is encouraged. The patient is then returned to a heated canopy bed, the burnt areas are covered with the *tulle gras* and gauze packs of saline. If the local use of sulphanilamide is indicated it is blown onto the raw areas before the *tulle gras* is applied. Between the daily baths the packs are re-wet or changed so that dry and sticky dressings are not allowed.

For the Hands.—Baths are used more frequently for the hands—two or three times each day. Meanwhile the hands are supported on pillows, the wrists are only slightly dorsiflexed and the fingers are flexed at the metacarpal joints.

For the Face.—A gamgee face mask soaked in saline solution is used. This is kept wet with an irrigator or an undine.

As soon as the areas are clean and begin to granulate—usually about the third week—any raw areas are skin grafted.

Advantages of Saline Régime.

1. Early function is permitted and is unembarrassed by dressings.

2. It does not inflict any further trauma on the burnt area. (The heterogeneous nature of most burns is borne out by rapid spontaneous epithelialization, so often noted in burns wrongly assessed as third degree. This contrasts notably with the findings after a tan has separated, where it always seems so well defined what is skin covered and what is raw area. I believe that many of these raw areas would be showing spontaneous proliferation had they not been tanned.)

3. Infection is controlled. Without addition of antiseptics dead tissue rapidly separates, burnt areas soon become clean. The method is compatible with the correct use of sulphanilamide, so that any streptococcal infection can be eliminated. For sulphanilamide to be effective locally the surface must be cleared of slough and débris, moisture is required, and the drug must be effectively distributed. Later on hypertonic saline solution can be used. This aids the control of infection and helps to reduce a granulating area to a regular firm condition.

4. Dressings are painless and atraumatic. The use of *tulle gras* prevents any damage to the surface. There is opportunity for airing and cleaning of beds. The malodour of infected tan is eliminated. Patients rapidly accommodate to the régime and favour it.

5. What is most important is that third-degree burns are ready in the shortest possible time for skin grafting.

Disadvantages of the Saline Régime.

There are two main disadvantages of the method:

1. It means extra work in the handling of patients and meticulous care in all details. It is, therefore, not always applicable.

2. There is a risk of the acquisition and spread of secondary infection and of cross-infection. This can be prevented only by careful aseptic routine, bacteriological control and use of sulphanilamide as indicated. Baths must be sterilized, otherwise they are a ready means of cross-infection, and cross-infection is a very real thing in a base hospital where a large number of recent and open wounds have to be handled.

The saline method has proved most satisfactory for burns of the extremities in which moderate grades of burn shock are well controlled by plasma transfusion. But it must still be regarded as on trial for severe and extensive body burns. Can they be safely exposed to the régime without the help of surface coagulation when there is a threat to life? This is for the physiologist and the research clinician to determine.

WHAT OF THE APPLICATION OF THIS TO WARTIME AND SERVICE CONDITIONS?

Obviously a saline bath routine cannot be applied in a forward unit or line of evacuation. In a civilian or fixed base hospital it can. Coagulation should be regarded as a measure for the local treatment of an extensive burn where there is a threat to life from fluid and protein loss which cannot be safely controlled by other methods. If these indications exist, as they often do under service conditions, everything must be done to limit, minimize and treat the bugbear of coagulation treatment, which is infection. To this end no burn should be tanned before its careful diagnosis and cleansing under the best surgical conditions available. The practice of using a coagulant type of first-aid dressing must cease.

What is the First-Aid Treatment of a Burn?

1. Any burn of the first or second degree—no larger than the size of a man's hand—which does not involve the hands, the face or the genitals, may be regarded as a minor burn. Morphine may be indicated for pain. The burnt area should be cleaned with soap and water and a dressing of "Vaseline" or soft paraffin or, preferably, a non-coagulant water-soluble jelly applied. If there is opportunity or facility for cleaning the burn, a coagulant dressing can be used with the advantage of its permanency; but so often there is no opportunity for adequate cleaning. A non-coagulant water-soluble jelly would

be well substituted for "Tannafax" as the first-aid dressing supplied in a tank, for example.

2. Any burn of greater severity or extent than that described as minor, or which involves the special regions mentioned, should be regarded as a major burn. Treatment of general condition and early evacuation are prime considerations.

Full doses of morphine are given the patient and his clothes are disturbed as little as possible, warm blankets are applied, hot drinks are given. Any severe burn shock is not usually manifest for five or six hours. It is likely to be serious if more than 25% of the body surface is involved.

A sterile towel, sterile lint or dry gauze or "Vaseline" gauze over the exposed parts are the indications of local treatment.

If hospital treatment or transport is not available in about four hours, plasma or serum is usually available for intravenous use under service conditions in a forward area or with a mobile team, and should be used. It is under these adverse conditions that coagulation of an extensive burn may be necessary. For this purpose, we may remember, the vital dyes are not such vicious coagulants and their coagulum is more easily removed.

Treatment when Coagulation is Necessary.

1. Coagulation must always be carried out under the best available surgical conditions.

2. The face, the hands and the flexure line should not be included in the coagulation process. After the *débridement* they should be dressed with saline solution over a non-adherent dressing. For transport, "Vaseline" gauze bandages can be used.

3. The tan should be removed at the earliest opportunity after its necessary function is complete.

Treatment when Tanning is Contraindicated or not Necessary as a Life-Saving Measure.

Wet saline solution dressings can be used and "Vaseline" gauze bandages applied as an evacuation dressing.

As the functional result of a burn must of necessity often be jeopardized by coagulation treatment, we must ask that these cases be to the fore of the priority list for air evacuation to a base hospital where there is a saline bath and a team who can use it. Any tan can be soaked off, early preparation and skin grafting carried out without that awful period intervening with septic absorption from large raw areas slowly healing with all the secondary disabilities usually attributed to burn scar.

Skin Grafting.

I cannot elaborate technical details of skin grafting here. Split skin grafts should be used when possible. The whole area is covered, and nothing is left to secondary intention healing. Induration, wrinkling and contraction of the grafted areas are minimized by their early use before any thick accumulation of granulation tissue.

For wounds which have been granulating a long time it is our practice to remove this excess granulation with a blunt instrument. For the chronic unhealed burnt area with deep fibrosis, excision of the wound and fibrotic area should be carried out before grafting. The final texture of an affected area is always improved by a period of massage with lanoline.

Results of these grafts are uniformly good only if the areas are adequately prepared. The correct use of local sulphanilamide where indicated has been the greatest factor in changing the results of free grafting on granulating wounds from a hit-and-miss business to one of a sound surgical procedure. The sulphanilamide and saline sequence or eusol and saline solution (when sulphanilamide is not indicated) together with a period of firm pressure on the areas to be grafted are the essentials. With adequate preparation it is as easy to grow skin in a desert tent as in any marble hall.

Pinch grafts are a second choice, as they leave much to secondary intention healing and scar; but we have had many burns in which there was insufficient donor skin available for free-hand cutting of split skin, which does restrict one to the limbs. There are also many cases in which general anæsthesia is contraindicated and unwarranted. Moreover, pinch grafts are an extremely useful palliative to hasten healing before any of the more elaborate plastic procedures should be commenced.

Vascular skin and fat flaps are indicated early when tendons of joints are exposed; but it is a general rule that whenever possible an open wound should be healed by a free graft before they are used. This is a principle of plastic surgry.

If it has been expected that I would expound on more elaborate and spectacular plastic procedures, the rearrangements and tissue migrations which are used for the various horrible deformities and disabilities seen as the result of burns, I must apologize. But I have the excuse that these procedures are all better prevented by primary treatment wherever possible, directed to the making good of any skin loss at the earliest possible opportunity. It is for this reason that we, as plastic surgeons, are opposed to the wholesale use of coagulation in the treatment of burns, and that we favour a method which does permit of early function, which does no further damage, which encourages healing, and which above all gives early preparation for the only adequate application for any severe burn—live skin.

BLOOD STORAGE ON ACTIVE SERVICE.[1]

By R. OFFICER,
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BLOOD banks have been in operation in many countries for some years, and have functioned satisfactorily. On active service the facilities which may be obtained in a large city are not available, and consequently the risks of using banked blood are greatly increased. Under civil conditions the blood may be collected, stored for some days and then used without having to be transported any great distance. On active service some modification of methods used in a large city is necessary, because several days may be spent in transporting blood the long distances which need to be covered. The blood must be collected and transported immediately, while still fresh, to the unit which is to use it, and which may, if necessary, store it.

Surgeons operating in forward areas have no time to collect blood during an action. Either they must collect the blood themselves during a quiet period and store it, or they must be supplied with blood from a source farther back on the lines of communication. Further, when a campaign is being fought in a malarial area all troops are potential carriers and should not be used as donors, except in a case of extreme emergency. Therefore, blood must be collected in a non-malarial area and sent forward to points where required.

The transport and storage of blood is not a procedure to be undertaken lightly. In order that it may be carried out successfully and safely, those who collect blood must have a full knowledge of the difficulties to be overcome and the dangers to be avoided, while those who administer it must be able to differentiate between blood fit for use and that which is unfit. Without such knowledge disasters are bound to occur, and blood storage is certain to fall into disrepute.

As an example, during a campaign a patient died while being transfused with stored blood. During the transfusion his temperature rose to 104° F., his pulse rate to 148, his respiratory rate to 60, and he became deeply cyanosed. Upon inquiry it was found that before the collection of the blood the bottles containing citrate solution had been left open on a laboratory bench for five days before being autoclaved. Examination of the blood remaining in the bottle showed it to be badly hæmolysed and almost black in colour. Culture of the blood produced a heavy growth of *Bacillus coli*, together with streptococci and anaerobic bacilli.

This blood had been stored for forty-eight hours only, and had been on ice all the time. The death of this patient was attributed to the use of stored blood; but the blame must surely lie with the collector and the administrator: with the former because he did not realize the danger of contamination from air-borne bacteria, with the latter because he was ignorant of the changes in the blood so produced.

The object of this paper is twofold: first to point out the changes which occur in blood during storage, and secondly to describe a technique for the collection, transport and storage of blood. This technique was devised and has functioned successfully during active service in the Middle East. Blood so collected has remained fit for use up to twelve days, during which time it was transported almost 250 miles by road.

[1] Accepted for publication on July 6, 1942.

BLOOD CHANGES DURING STORAGE.

Only those changes which render the blood unfit for use, and which can be seen with the naked eye, will be discussed. Changes which can be seen serve as a guide to the fitness of the blood for use. Of these, hæmolysis and changes due to infection are of outstanding importance. The presence of either or both indicates danger, and the blood should not be used.

Before the abnormal is considered, the standards of the normal should be appreciated. Figure I illustrates blood fit for use. It was collected into a 2·5% solution of glucose in 0·45% saline solution, and maintained at a temperature of 4° C. for six days. After four days of storage the bottle was briskly shaken to imitate the effects of transportation, and then allowed to settle. The points to be noted are the clear amber colour of the plasma, the red colour of the layer of cells beneath, and the very sharp line of junction between the two.

FIGURE I. Blood stored with glucose (2·5% in 0·45% saline solution) for six days. It is fit for use.

FIGURE II. Blood stored with glucose (2·5% in 0·45% saline solution) for twelve days, and then shaken vigorously and allowed to settle for twenty-four hours. The signs of early hæmolysis are shown. It is unfit for use.

Hæmolysis.

At the time of collection of blood the red cells are of different ages. The older cells soon lose their vitality, their hæmoglobin being set free and becoming diffused through the plasma. As this occurs a pinkish tint appears in the plasma (Figure II), gradually spreading upwards from the red cell layer. As further hæmoglobin is liberated the plasma becomes progressively more red in colour (Figures III and IV). At the same time the junction between cells and plasma becomes less sharply defined, and in the late stages a hazy bright red layer, one to two millimetres in breadth, may develop at this site.

The rate at which hæmolysis occurs depends upon the fragility of the red cells. During the storage of citrated blood, red cell fragility increases very slowly until the fourth or fifth day and then more rapidly. As a result a pink coloration appears in the plasma on about the seventh day and becomes progressively deeper red in colour. In order to determine the presence of hæmolysis in blood which may appear normal, the bottle should be thoroughly shaken and the blood allowed to settle again for approximately twenty-four hours. By this means hæmoglobin already set free, but confined to the red cell layer, will be mixed with the plasma and immediately recognized. Such shaking occurs during transport and so transported blood should, if possible, be given time to settle before administration. The agitation resulting from transportation, besides bringing to light free hæmoglobin, destroys the more fragile cells, thus releasing further hæmoglobin. This is illustrated by Figure II. The specimen shown appeared normal before being vigorously shaken. It was allowed twenty-four hours to settle, after which the upper portion of the plasma is seen to be reddish-yellow in colour. The deeper red colour in the lower half of the plasma is due to the presence of cells which have not yet settled and must not be mistaken for hæmolysis.

FIGURE III. Citrated blood alone, stored for fourteen days, then shaken and allowed to settle for twenty-four hours. The signs of gross hæmolysis are shown. It is unfit for use.

FIGURE IV. Citrated blood alone, stored for twelve days. The tourniquet had been left on the donor's arm for some time before collection. Hæmolysis is present and the dark colour of the cell layer resembles blood infected with *Bacillus coli*. It is unfit for use.

FIGURE I.

FIGURE II.

FIGURE III.

FIGURE IV.

If an appropriate proportion of glucose is mixed with blood during collection, the onset of hæmolysis can be considerably delayed.[1] Isotonic (5·4%) glucose solution is recommended to be mixed with the blood in the proportion of 1 to 2. In a mixture of this nature the fragility of the red cells remains constant up till fourteen days,[2] and does not increase as occurs in citrated blood stored alone. On active service pure glucose solution alone is not always obtainable, but by mixing equal quantities of distilled water and 5% glucose in 0·9% saline solution an isotonic solution (2·5% glucose in 0·45% saline solution) was obtained. Such solution used in the proportion of one volume to two volumes of blood delayed the onset of visible hæmolysis till the fourteenth day—a result not as favourable as when isotonic glucose solution is used, but a distinct improvement upon citrated blood stored without the addition of glucose.

The administration of slightly hæmolysed blood usually results in the patient's having a "reaction", the severity of which depends upon the degree of hæmolysis and upon the fragility of the red cells. The reaction takes the form of a rise in temperature and pulse rate, usually associated with shivering and followed by pallor and sweating. It has been demonstrated that the cells of citrated blood, stored for six days, exist in the circulation of the recipient for twenty-four to forty-eight hours only.[2][3] This would not occur with blood stored with glucose until approximately the fourteenth day, because the red cell fragility is not increased. Therefore the limit of storage for citrated blood should be four days, while that for glucose-blood should be ten days, some days less in each case than when hæmolysis would become appreciable. Only by doing this can one be sure that the patient will retain the blood cells long enough for them to be of therapeutic value.

Apart from ageing, hæmolysis may also be caused by the shaking of blood during transportation. This shaking is more marked in a partly filled bottle because the fluid splashes about. In a completely filled bottle splashing cannot occur, the liability to hæmolysis being thus reduced. The addition of glucose solution is of value because, owing to the extra volume, the "Soluvac" type of bottle used in the Army can be completely filled.

Hæmolysis is also caused by freezing the blood, so that its temperature should never be allowed to fall below 2° C.

Infection.

The growth of bacteria in preserved blood does not produce any characteristic visible changes, unless hæmoglobin is altered.

Should there be any pigment change, the red cell layer becomes reddish-black or even black, an appearance similar to that seen in Figure IV. *Bacillus coli* produces this dark coloration, whereas experimental contamination with staphylococci, streptococci, *Bacillus subtilis* and diphtheroids produced in each instance no colour change in the red cells, but all caused extremely rapid hæmolysis of a marked degree. An appearance indistinguishable from that shown in Figure III was produced within twelve hours, despite the fact that the blood was kept at a temperature of 4° C. It must be emphasized that bacteria introduced into freshly collected blood, either accidentally or experimentally, will grow and will produce extensive hæmolysis within twenty-four hours, even though the blood is kept at an ideal temperature (2° to 4° C.) the whole time.

Thus it will be seen that, without culture, it is not possible to determine whether hæmolysis has been due to infection or to age. This forms another very good reason why hæmolysed blood should not be used for transfusion.

Blood collected from a cyanosed arm is very dark in colour and may be mistaken for blood altered by infection or age. Collection of blood in this state of cyanosis is due to the leaving of the tourniquet on the donor's arm for some time before insertion of the needle, or to the collection of the blood having taken too long owing to poor flow. Figure IV illustrates blood collected after the tourniquet had been left on for some minutes and could easily be confused with blood infected with *Bacillus coli*. The red cell layer becomes darker in colour with age (compare Figure I with Figures II and III). Blood, therefore, should be bright red in colour (Figure I) when collected in order that this colour change may be used as an index of age or infection. It is most important, therefore, in order to collect blood of a bright red colour, that the tourniquet should not be applied until immediately before the needle is inserted, and that the collection should take no longer than five to seven minutes.

Prevention of infection depends entirely upon scrupulous care in the sterilization of the apparatus and upon the avoidance of contamination during collection of the blood. Under wartime conditions bottles often have to be sterilized some days before they are used. They should be so sterilized that they contain a vacuum, and if at the time of use this vacuum is found to be deficient or absent, it is obvious that air has entered the bottle since sterilization. Such a bottle is contaminated and must not be used. Care also should be taken that air is not sucked into the bottle through the collecting needle either before or after the collection of the blood. If such air does enter the bottle, bacteria are introduced with it. Whether such bacteria are destroyed by the blood itself or whether they continue to grow in the blood, only fate can decide. Such a gamble has no place in blood storage.

To sum up, blood collected for transport to forward units should be collected in a sterile bottle uncontaminated by outside air. It should be mixed with half its volume of isotonic glucose solution and should be bright red in colour. The bottle should be completely filled. When stored at approximately 4° C. such blood will not deteriorate when carried even long distances, providing that it is transported while fresh and not when some days old.

After transport it should be allowed twenty-four hours to settle and should be used only if no signs of hæmolysis are present and if no older than ten days. Ten days is the upper limit; but the sooner the blood is given, the longer will its effect last.

TECHNIQUE OF COLLECTION OF BLOOD FOR STORAGE.

Apparatus.

The whole of the apparatus required is contained in the standard Australian Army transfusion pannier. This apparatus has been used under many and varied conditions during the past two years, always with complete satisfaction.

The "Soluvac" bottles (Figures I to IV) contained in each pannier were designed to enable them to be used for all intravenous operations. The contained sterile fluid (for example, normal saline solution, 5% glucose in normal saline solution) may be administered as required, and the empty bottle then used either for the immediate administration of a transfusion or for the storage of blood. To enable all of these to be carried out safely the method of sealing a bottle is, of necessity, rather complex; but its assembly can be mastered easily by nursing orderlies after very little study.

Figure V represents the "Soluvac" bung-assembly in section. A brief description of the parts is as follows: 1. The neck of the bottle onto which

a metal collar (6) is screwed. 2. The rubber bung, with a shoulder which fits onto the top of the bottle. 3. The inlet through which air flows when the blood is being given. 4. The self-sealing "Latex" rubber disc, which has a nipple on its under surface. This nipple fits into and seals the air inlet (3). 5. The metal disc with a nipple on its under surface. The nipple passes through a hole in the rubber disc (4) and fits into a recess in the top of the bung. 6. The metal collar which screws onto the neck of the bottle and presses all the components together, thus sealing the flask. 7. The metal cap with a thin rubber washer between it and the metal disc. This cap screws onto the metal collar, thus keeping the top of the metal plate and exposed parts of the rubber disc sterile.

In order that the bottle shall remain properly sealed, the components must be correctly assembled. They are so made that if the nipples beneath the rubber disc and beneath the metal plate are correctly fitted into the air tube and the recess on the top of the bung respectively, then the parts are automatically in their correct positions. When the collar is being screwed into position there is a tendency for the metal plate and the rubber disc to be rotated. This tendency must be counteracted by firm pressure on the top of the metal plate with the thumb of one hand while the collar is tightened with the other hand.

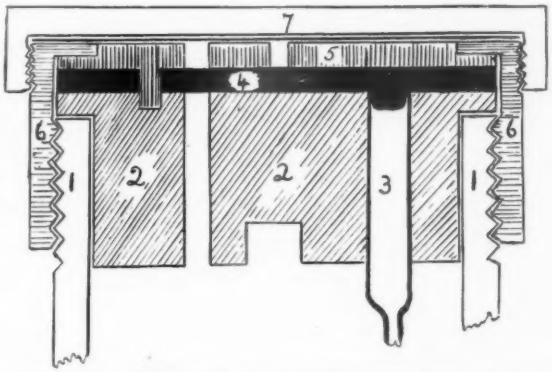

FIGURE V. Illustrating the "Soluvac" bung-assembly in section.

Cleaning of Apparatus.

The ease with which all transfusion apparatus can be cleaned depends upon its treatment after being used. No blood should be allowed to remain in any part at the conclusion of a transfusion. The whole apparatus should be disassembled at once and placed in a bucket of cold water, rubber tubing and needles being syringed through with a Higginson's syringe. Such a bucket should be placed at the bedside of all patients receiving transfusions.

Thereafter glassware should be treated with chromic or sulphuric acid for twelve hours and then rinsed with boiled water, followed by three changes of freshly distilled water. Rubber parts and needles should be thoroughly washed with soapy water and then rinsed with three changes of distilled water. When chromic or sulphuric acid is unobtainable, scrubbing the glassware with soap and water, although not ideal, will suffice.

Sterilization of Apparatus.

Giving sets, taking sets, blood filters and instruments are wrapped separately in lint or gamgee tissue and then placed in unbleached calico wrappers. These bundles are sterilized by autoclaving for thirty minutes at fifteen pounds' pressure, followed by vacuum for twenty minutes.

Sterilization of Bottles.

Three hundred and fifty cubic centimetres of isotonic (5·4%) glucose solution are placed in the bottle. "Soluvac" 5% glucose in 0·9% saline

solution diluted with an equal volume of distilled water may be used, but only if isotonic glucose solution cannot be obtained.

The components of the bungs, with the exception of the metal caps, are assembled, but the metal collar is screwed on only sufficiently just to engage the threads on the necks of the bottles. The bottles, together with the caps, are placed in the autoclave and, with the door loosely closed, heated for ten minutes to drive off most of their contained air. Then the autoclave door is firmly closed and the bottles are sterilized for thirty minutes at fifteen pounds' pressure.

At the end of this time the main steam supply is turned off, the chamber valve being left open. If the autoclave is "Primus" heated, merely turn off the heater. Neither vacuum nor "dry heat" is to be used. The whole autoclave and its contents are left to cool, so that the chamber pressure becomes reduced at a rate corresponding to the fall in temperature, evaporation of the glucose solution thus being avoided.

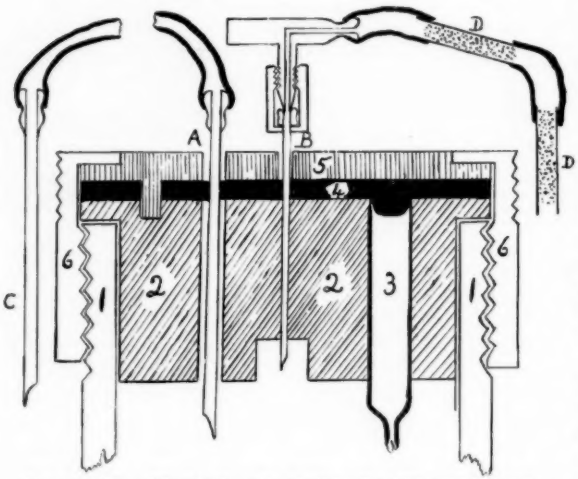

FIGURE VI. Illustrating in section the "Soluvac" bung assembled for the collection of blood.

When the chamber pressure reaches zero (that is, atmospheric pressure), the door is opened and the bottles may be removed as their temperature is now just below boiling point. This cooling stage occupies approximately forty-five minutes. Before being allowed to cool further, each bottle is removed separately, the hands being protected with a sterile towel. Each bottle is placed on a table and the collar is screwed down tightly. While the collar is being tightened, rotation of the metal disc is prevented by firm pressure on it with a sterile swab. The metal cap is now screwed into place. The bottles are thus completely sealed and, when cool, will contain a strong vacuum. Occasionally the glucose solution in one or two bottles at the back of the autoclave will have partly evaporated; these should be "topped up" and resterilized.

Collection of the Blood.

Donors from whom blood is to be collected for storage should have good veins because the blood has to be collected rapidly. They should have only a light non-fatty meal beforehand, so that their blood will contain a minimum of free fat.

The arm band of a sphygmomanometer is placed on the donor's arm and the pressure raised to 70 millimetres. A suitable vein is selected, local anæsthetic injected and a small puncture made in the skin at the proposed site of puncture. Pressure in the armband is then released.

An ampoule of 4% sodium citrate is opened and the "donor" needle (Figure VI, C) of a taking set is inserted until well below the fluid. After

removal of the cap from a "Soluvac" bottle, the "bottle" needle is pushed through the rubber disc as shown in Figure VI, A. Immediately the vacuum sucks citrate solution into the bottle, but care must be taken that no air is sucked in as well. As soon as 70 cubic centimetres of the solution have entered the bottle the rubber tubing is pinched to stop the flow. The rubber tubing is so held until the whole of the vacuum has been dispersed, which is brought about by inserting the bung perforator as shown in Figure VI, B. Air can be heard flowing into the bottle through the two air filters attached to the perforator (Figure VI, D), indicating that the perforator is placed correctly. If no air flows, then the perforator has been inserted obliquely and the point of the needle is resting in the substance of the bung and not in the recess on its under surface. If such is the case the perforator must be removed and inserted correctly.

If no vacuum is found in the bottle it must be discarded. Absence of the vacuum may be due either to incorrect assembly of the bung or to the use of a rubber disc which has been perforated a number of times. In the latter case a piece of old rubber glove stuck over the area will remedy the defect.

When the air has ceased to pass through the air filters the rubber tubing may be released and a Higginson's bulb is attached to the end of the air filter.

The pressure in the armband is again raised to 70 millimetres, and the "donor" needle inserted into the selected vein.

Throughout collection the flask is gently rotated to ensure mixing, and continuous suction is applied by means of the Higginson's bulb.

When the required volume of blood, 700 cubic centimetres (approximately 24 ounces) is collected, the tourniquet is released and the "bottle" needle removed. The total volume in the bottle is now about 1,100 cubic centimetres, which almost fills it (Figures I and II). The perforator is removed, the metal cap replaced on the bottle and the bottle placed in cold storage.

The blood remaining in the tubing after removal of the needles should be run into a small test tube containing citrate solution. This test tube is attached to the bottle and its contents are used for cross-matching if required.

The bottle should be labelled with the donor's group, the date of collection and the amount of blood collected.

Storage.

Blood should be stored at between 2° and 6° C. The ideal method is in an electrically operated and thermostatically controlled refrigerator. Failing this, well insulated iceboxes are obtainable which will keep the blood within the required temperature range, and in which ice will last for up to ten days without replenishment. More easily handled are insulated "hot boxes" supplied for keeping food hot, but they require replenishing with ice every two to three days.

Kerosene operated refrigerators have not proved satisfactory, as it is difficult to keep the temperature constant. On one occasion a whole batch of blood stored in a kerosene refrigerator became frozen. The contents of those bottles which were not broken were completely hæmolysed.

SUMMARY.

The changes which occur in blood during storage and which render it dangerous to administer are discussed and illustrated.

The storage of blood in glucose solution is recommended.

A technique for the collection of blood for storage using the standard Australian Army equipment is described.

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EXPERIENCES WITH "PENTOTHAL SODIUM" IN AN AUSTRALIAN GENERAL HOSPITAL.[1]

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HAVING used "Pentothal Sodium" for over 1,400 cases in an Australian general hospital, we have come to consider it a most useful drug for the type of operation most commonly met with in forward areas.

It is particularly indicated in operations which are not expected to take more than twenty minutes, that being the average time of anæsthesia obtained from 20 cubic centimetres of the solution. We found it to be the most useful anæsthetic for the following operations:

1. Removal of foreign bodies and excision of wounds in patients exhibiting little or no shock. These form the bulk of the operations met with in forward areas.
2. Smaller amputations.
3. Reduction of fractures and dislocations.
4. Manipulation of joints.
5. The cleaning and dressing of burns.
6. Ophthalmic operations.
7. Myringotomy.
8. Minor surgical procedures such as incision of abscesses and suturing of lacerations.

The frequency with which these operations were encountered may be judged from the fact that, at one stage, "Pentothal Sodium" was used in 105 out of 130 consecutive cases.

CONTRAINDICATIONS.

The contraindications to the use of "Pentothal Sodium" may be enumerated as follows:

1. Operations on the face, nose or throat, in which blood may enter the pharyngeal and laryngeal regions. In anæsthesia with this drug, particularly in its lighter stages, laryngeal irritability is increased and severe spasm may easily occur from the presence of blood, vomitus or excess mucus.
2. Infections of the neck and pharyngeal regions.
3. Sepsis.
4. Gross respiratory disease or dyspnœa from any other cause.

While not regarded as an absolute contraindication, the presence of shock means that the drug must be given with caution because of its tendency to lower the blood pressure. Whether or not it should be used, should depend on the merits of the particular case; but it must be remembered that much less than usual of the anæsthetic will probably be required to keep the patient anæsthetized. In one such case 15 cubic centimetres were sufficient for anæsthesia of forty-five minutes' duration.

[1] Accepted for publication on April 30, 1942.

It should also be used with caution in cases involving the dilatation of the anal sphincter, as this may cause laryngeal spasm and should not be attempted under light anæsthesia.

PREMEDICATION.

Where the patient had not had a recent injection of morphine, we gave one-sixth of a grain with one one-hundred-and-fiftieth of a grain of atropine, the latter being advisable, particularly with the larger doses of "Pentothal Sodium", to prevent mucous secretion which may precipitate laryngeal spasm. When possible, the premedication was given one hour before operation. In many cases the patients had had large doses of morphine before being admitted to hospital, but even when doses up to half a grain had been given as late as two hours before operation, we did not have any anxiety from respiratory depression *per se*. We found that a pre-operative injection of morphine was of definite value in prolonging the effect of the anæsthetic, and, when a dose of ten cubic centimetres was given, the morphine appeared frequently to make the difference between having the patient move when an incision was made and securing a short period of anæsthesia sufficient for an operation lasting a minute or two without any movement.

The fact must always be borne in mind that the greatest danger in the use of "Pentothal Sodium" lies in its depressant effect on the respiratory centre and, should trouble arise from this cause, oxygen and carbon dioxide must be promptly administered. Analeptics are not considered to be effective in resuscitation from "Pentothal Sodium" overdosage.

ADMINISTRATION.

The best site for injection is into a vein slightly below the bend of the elbow, and venipuncture will be easier if a venous junction is used. If these veins cannot be used, the injection may be made into a vein anterior to the medial malleolus or into one of those on the dorsum of the hand or foot. When a blood transfusion is being given, the injection may be made into the rubber tube close to the cannula which is in the patient's vein. Manual compression of the arm while the patient opens and closes his fist is nearly always sufficient to cause enough venous engorgement for the venipuncture to be carried out; but if this is still insufficient, a few light slaps over the site of the injection will usually cause the vein to become more prominent.

The technique of administration is based on that originated by Lundy. The patient is asked to count while a 5% solution of the drug is injected at the rate of one cubic centimetre every five seconds, until he has stopped counting. The amount given is then noted and the injection continued at the same rate until half as much again has been given. After a pause of a half to one minute, the operation may be begun, and from then on amounts of 0·5 cubic centimetre to 1·0 cubic centimetre are injected as required. It should be noted that smaller amounts will be necessary as the operation proceeds, and, in view of this, it may be found advisable to inject smaller quantities more frequently in order to prevent clotting in the needle. The administration may be helped, particularly when assistance is lacking, by the use of a simple splint to retain the elbow in the extended position. This reduces the possibility of a sudden flexing of the arm displacing the needle from the vein. When it is found necessary to move the patient to the X-ray room, it is usually preferable to fix the syringe to the arm with adhesive plaster rather than make another puncture with the patient anæsthetized. A syringe with an eccentric nozzle makes venipuncture much easier and is more easily fixed to the arm without the needle being pulled from the vein. In cold weather

it is advisable to warm the ampoule of distilled water in order to facilitate solution of the drug.

Should the operation take longer than was expected, more "Pentothal Sodium" may be given or the anæsthesia may be continued with either nitrous oxide and oxygen or chloroform. Because of the laryngeal irritability, and perhaps some degree of respiratory depression, the change to ether is usually not a smooth one, coughing and laryngeal spasm being very easily induced. For this reason "Pentothal Sodium" was not considered satisfactory for routine induction of anæsthesia and in most cases we preferred to continue with the "Pentothal Sodium" rather than change to ether. With the intravenous anæsthetic alone most of the coughing occurred while the patient was emerging from the anæsthetic and sneezing was very rare.

It is advisable not to use an artificial airway unless the patient is deeply anæsthetized, as it also may induce laryngeal spasm or retching. However, we did not find it necessary, as turning the patient's head to one side or holding the jaw forward proved enough to ensure a satisfactory airway. One of the outstanding features of this type of anæsthesia is the clearness of the airway, and this advantage over inhalation anæsthesia is particularly noticeable when it is necessary for the patient to be in the prone position. While he is in this position, the patient's respiratory efforts are not so clearly visible and particular care is necessary in observing his respirations. This also applies when an operation is being performed under the X-ray screen. In this case it is advisable to have one hand on the patient's chest so that his respiratory movements may be felt while the room is in darkness.

SIGNS OF ANÆSTHESIA.

The most important sign indicating the depth of anæsthesia is the amplitude of the respirations. It will be found that as anæsthesia deepens the respirations become shallower. Signs that the anæsthesia is too light are frowning, swallowing, and slight movements, particularly of the fingers. The eye signs, particularly where light anæsthesia is being aimed at, are unreliable and difficult to elicit while an intravenous injection is being given.

Two deaths occurred in the series, both being in the first 300 cases, after which over 1,100 administrations were given without any further mortality.

One death occurred in a case in which there were severe lacerations of the mouth, neck and tongue which had temporarily stopped bleeding. With the recurrence of bleeding during the operation severe laryngeal spasm occurred and respiratory effort stopped almost immediately.

The second patient who died suffered from a fractured spine, a penetrating wound of the flank and shock, and his condition was regarded as hopeless. He had been given half a grain of morphine three hours previously and had to be anæsthetized in the prone position. Death was apparently due to the combination of respiratory depression and shock.

In forward areas, where large numbers of short operations are usually performed, the quick smooth induction of "Pentothal Sodium" gives it a decided advantage over the inhalation anæsthetics in saving time. This is particularly so in hot weather when ether inductions are usually prolonged and are very wasteful of ether. A further important advantage is the quick recovery which enables the patient to be removed from the theatre without the danger of sudden respiratory obstruction, and later this, as well as the absence of post-operative vomiting, leaves him in much better condition for early evacuation than if he has had ether.

Even more time could be saved if portion of the supplies of the drug, say a half, was in the form of one gramme ampoules, as this amount is used more frequently than the smaller size. At present, to obtain anæsthesia

lasting more than a minute or two it is necessary to open four ampoules and mix two separate solutions. In my own series of 450 cases the following dosages were used: 0·5 gramme or less in 43% of the cases; 0·5 gramme to 1·0 gramme in 50% of the cases; more than 1·0 gramme in 7% of the cases.

The technique of administration is simple, and we have found that medical officers who have not previously used the drug have had little difficulty in becoming familiar with it.

We feel from our experience of it that "Pentothal Sodium", used with due regard for the contraindications, is a safe anæsthetic and should occupy an important place in military surgery of forward areas, particularly in hot climates and areas where transport is a problem.

SOME EXPERIENCES GAINED IN THE TREATMENT OF WAR WOUNDS OF THE ABDOMINAL VISCERA, AND THE RESULTS OBTAINED AT A FORWARD OPERATING AREA IN THE MIDDLE EAST.[1]

By C. A. M. Renou,
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Through unforeseen circumstances resulting from the rapidity of movement of modern warfare, it fell to the lot of an Australian general hospital to be almost overtaken by the fighting, and to become the medical unit of an invested garrison. This hospital was situated within a few miles of the front line, and this article is a record of the abdominal war wounds which passed through it during the four and a half months between April and August, 1941.

During this period the total number of patients with wounds involving abdominal viscera numbered 72. Of these, 34 died and 38 were eventually evacuated to base, the mortality rate being 47%.

The nearness of the hospital to the front line meant that the great majority of patients were operated upon early, usually within six hours of injury. One patient suffering from multiple penetrating wounds of the small intestine was "on the table" within one hour of the receipt of his injury.

Classification.

On admission it was found that the cases could be placed, according to the clinical state of the patients, in one of four groups: (i) Cases in which the patient's condition was so good that operation could be undertaken without delay. (ii) Cases in which the shock-hæmorrhage syndrome was pronounced and resuscitation was necessary before operation. (iii) Cases in which marked evidence of internal hæmorrhage was present. (iv) Late cases, with peritonitis manifest on admission.

Despite their good condition, patients falling into the first group were, as a rule, placed in the resuscitation chamber and given warmth and morphine whilst the theatre was being prepared for operation.

When the shock-hæmorrhage syndrome was pronounced, the resuscitation period was of necessity longer; and in this, and the third group, when the signs of internal hæmorrhage were even more pronounced, blood transfusion was instituted without delay. It was found more satisfactory, once transfusion had been commenced in the resuscitation chamber, for the transfusion to be continued by the slow drip method in the theatre during the operation.

Patients falling into the fourth group were few, as fortunately it was a rarity for a soldier to remain lying in the field for many hours after being wounded. As has been already said, the distance to be travelled from the front line to the hospital was short.

X-Ray Investigation.

On the way from the resuscitation chamber to the theatre all patients, with the exception of those with single through-and-through revolver, rifle or

[1] Accepted for publication on March 3, 1942.

machine-gun wounds, were examined with the screen in the presence of the surgeon. For this procedure it was unnecessary to remove the patient from his stretcher or to disturb him or his transfusion in any way.

The foreign body was localized and the skin was marked in two planes.

From the anatomical site of the wound of entry and the situation of the missile thus localized, it was possible for the surgeon to form an estimate of the viscera injured and to decide upon his incision and operative approach.

X-ray films of the abdomen were not taken as a routine, but only in those cases in which the foreign body could not be easily seen under the screen. This difficulty occasionally occurred and was due either to the poor radio-opacity of the foreign body or to its anatomical situation when close up against bone.

The supply of X-ray films was limited, and this routine screening, beside conserving the films for other work, proved to be a valuable factor in saving time.

ANÆSTHESIA.

The anæsthetic of choice was found to be ether given by the "open" method, following an induction by ethyl chloride, chloroform and ether mixture, or, in certain cases, ether alone.

Gas and oxygen failed to produce sufficient relaxation of the abdominal musculature, but local anæsthesia was adopted in a few selected cases with satisfactory results.

SKIN PREPARATION.

The preparation of the skin was delayed until the patient had reached the theatre and generally until he had been anæsthetized. Preparation consisted of shaving, of washing with soap and water, and of the application in turn of petrol, spirit and lastly 2% iodine in spirit.

THE OPERATION.

The wounds of entry and exit were, when situated in the abdominal wall, dealt with before laparotomy had been commenced.

Small gunshot wounds remained in most cases untouched and were dressed with sulphanilamide powder and "Vaseline" gauze. All other wounds were excised down to the peritoneum and were in some cases sutured. In other cases, when drainage was necessary, the tube was introduced into the abdominal cavity through the excised wound.

When the wound was posterior (for example, in the buttock) it was freely excised and remained unsutured, and was dressed with sulphanilamide powder and "Vaseline" gauze. This procedure rendered all further turning of the patient unnecessary.

During the laparotomy—in all cases and not only if hollow viscus content was found free in the peritoneal cavity—the alimentary canal was carefully inspected from stomach to rectum before any repair was carried out. As each gut perforation was exposed it was clamped, and, after complete inspection, repair by suture or resection of the injured area was performed.

In cases in which hollow viscera were injured the after-treatment, with few exceptions, consisted in adequate sedation (morphine), the withholding of food or fluid by mouth, and the use of continuous intravenous drip saline therapy (5% glucose saline solution). Sulphanilamide was given by mouth or, if vomiting was at all pronounced, by the intramuscular or intravenous route.

The mouth was washed out at frequent intervals, but no fluid was allowed to be swallowed until at least forty-eight hours after the operation.

The intravenous administration of saline solution was kept going until all vomiting had ceased and until the patient had taken fluid by mouth for at least twenty-four hours without ill effect.

When vomiting had persisted after the patient had recovered from his anæsthetic, a Rehfuss tube was passed nasally and the stomach was kept empty. Aspiration through this tube was maintained until the return showed no trace of colour. On one occasion it was not removed until the sixth day.

In all cases patients were held, and they were not evacuated until they were fit to travel 250 miles by ship to a base hospital. This evacuation took place somewhere between the tenth and twenty-first days.

DETAILS OF CASES.

It may be of interest to know the frequency with which the various abdominal organs were injured in this series and to compare the figures with those of "The Official History of the Great War (1914-1918)". This information is given in Table I.

TABLE I.

Viscera Injured.	Present Series. (Number of Cases.)	Official History of the Great War (1914–1918). (Number of Cases.)
Stomach	9	82
Small intestine	20	363
Colon	25	252
Rectum	3	21
Bladder	5	45
Liver	7	163
Spleen	6	54
Kidney	9	74

A more detailed analysis of the present series is set out in the following sections.

Wounds with Injury to Hollow Viscera.

Stomach.—The wounds involving the stomach are analysed in Table II.

TABLE II.

Extent of Wound.	Number of Cases.	Number of Patients Evacuated to Base.	Number of Deaths.
Stomach only	2	—	2
Stomach and other hollow abdominal viscera	1	—	1
Stomach and solid abdominal viscera	2	1	1
Stomach and thorax (one with superadded injury of small gut)..	4	—	4
Total cases of stomach injury	9	1	8

Of these patients only one recovered to be evacuated to base, thus leaving an immediate mortality of 88%.

The site of the skin wound and the type of missile, together with a summary of the viscera involved and progress details in each case are shown in Table III.

In the case in which recovery occurred (number nine in the series) the only indication that the right kidney had been perforated by the missile was the site of the skin wound and the presence of a transient hæmaturia for the first thirty hours after injury. The stomach had been perforated only once, on its under-surface near the greater curvature, and the foreign body was felt to be inside the stomach lumen.

TABLE III.

Missile and Site of Wound.	Viscera Involved.	Progress.
(1) Gunshot wound. Entrance only. Left chest posterior.	Left lung, diaphragm, cardiac end of stomach.	No operation; died in less than twenty-four hours of admission.
(2) Bomb wound. Entrance only. Right chest postero-lateral.	Right lung, mediastinum, diaphragm, body of stomach.	No operation; died thirty hours after admission.
(3) Shell wound. Entrance only. Left lateral chest wall.	Left lung, diaphragm, stomach, duodenum.	Blood transfusion, laparotomy. Gastric and duodenal wounds oversewn; death forty-eight hours after operation.
(4) Gunshot wound. Entrance only. Left lower ribs.	Stomach, transverse colon, jejunum.	Blood transfusion two pints. At laparotomy the foreign body was recovered, and the hollow viscera wounds were oversewn. Death in less than twenty-four hours.
(5) Bomb wound. Entrance only. Epigastrium.	Anterior and posterior stomach wall, pancreas, retroperitoneal hæmorrhage.	Blood transfusion, laparotomy; stomach wounds oversewn, drain tube down to pancreas. Death on third day.
(6) Shell wound. Entrance only. Lower part of left side of chest.	Diaphragm, stomach, right gastro-epiploic artery. Gross hæmoperitoneum.	Blood transfusion three pints. At laparotomy the gastro-epiploic artery was ligated, the stomach wounds were oversewn, and the foreign body was recovered. The patient's condition was very low, and he died on the table before the operation could be completed.
(7) Gunshot wound. Entrance only. Epigastrium.	Stomach; gross retroperitoneal hæmatoma.	Blood transfusion, laparotomy, wounds of stomach oversewn. No recovery from initial shock and hæmorrhage. Death in two days.
(8) Bomb wound. Entrance only. Right loin.	Stomach.	This man had been a wounded prisoner of war, and was recaptured. He did not reach hospital till nine days after he was wounded. He died three days later from peritonitis.
(9) Shell wound. Entrance only. Right loin.	Right kidney, stomach.	Blood transfusion. At laparotomy the one wound in the stomach was oversewn, the foreign body being in the lumen of the stomach.

In four of the eight cases in which the patient died, the missile had penetrated the thorax as well as the abdominal cavity. In only two of the remaining four cases could it be said that the stomach was the only viscus injured, and in one of these the patient reached hospital much too late to benefit from surgical interference. The other patient did not recover following operation, and death was due to shock and hæmorrhage.

In the treatment of only one patient (number five in the series) was a drain tube used, and this because of the accompanying pancreatic injury and the extensive retroperitoneal hæmatoma.

All nine patients were, on admission, extremely ill. They were all shocked, and each one suffered from some degree of respiratory distress. It was impossible before operation to do more than to suspect that the stomach had been perforated, and so it was not long before this type of case was regarded as one of a penetrating wound of the upper part of the abdomen rather than of the stomach itself.

It is evident that the symptoms and signs produced were in part caused by the injury to the retroperitoneal nerve plexuses and blood vessels of the upper part of the abdomen.

Small Intestine.—The details of the wounds involving the small intestine are set out in Table IV.

TABLE IV.

Extent of Wound.	Number of Cases.	Number of Patients Evacuated to Base.	Number of Deaths.	Mortality. (Percentage.)
Small intestine only	9	5	4	44
Small intestine and other hollow abdominal viscera	14	2	12	86
Small intestine and solid abdominal viscera (spleen)	1	1	—	—
Small intestine and other hollow abdominal viscera and solid abdominal viscera	2	—	2	—
Small intestine, with other severe superadded injuries	3	1	2	—
Total	29	9	20	69

The total number of cases in which the small bowel was injured was 29, and of this group the immediate mortality was 69%.

In only two cases was gut resection with end-to-end anastomosis necessary, and this procedure was adopted in each case because there were several large perforations within a short distance of one another. When the mesentery was damaged the bleeding was controlled by Spencer Wells forceps and ligature, and in no case was blood vessel damage found sufficiently extensive to impair the vitality of a segment of bowel. When the small intestine was the only viscus injured the immediate mortality was 44%, but when the large bowel was also involved this mortality rose to 86%.

Colon.—The details of the wounds of the colon are shown in Table V.

TABLE V.

Extent of Wound.	Number of Cases.	Number of Patients Evacuated to Base.	Number of Deaths.	Mortality. (Percentage.)
Colon alone	8	6	2	25
Colon and other hollow abdominal viscera	12	2	10	83
Colon and solid abdominal viscera	1	—	1	—
Colon and other hollow abdominal viscera and solid abdominal viscera	1	—	1	—
Colon and other severe extraabdominal injuries	3	2	1	—
Total	25	10	15	60

The total number of patients treated for colon injury was 25; ten of them recovered and were ultimately evacuated to the base. The immediate mortality therefore was 60%.

In eight patients the colon alone was involved. Two of these died, but of the six survivors, two were found at operation to have had minute perforations of the caecum and ascending colon which had almost sealed themselves. In these two cases no obvious bowel content had leaked into the peritoneal cavity.

In only one of the 25 cases was colostomy deemed advisable. No patient had injury sufficiently severe to call for excision of part of the large bowel. In 24 patients the perforations were oversewn and the abdomens were closed with or without drainage down to the site of perforation.

Rectum.—The details of wounds of the rectum are shown in Table VI.

TABLE VI.

Extent of Wound.	Number of Cases.	Number of Patients Evacuated to Base.	Number of Deaths.
Rectum (extraperitoneal)	2	—	2
Rectum and other hollow abdominal viscera	1	—	1
Total	3	—	3

Of the patients with rectal wounds, the two in whom the injury was extraperitoneal were suffering from through-and-through wounds from one buttock to the other. In both there was extensive damage to the soft tissues of the buttocks and the lower part of the sacrum. Blood transfusions were in each case necessary, and at operation extensive excision of post-rectal soft tissue and bone was carried out. Neither patient picked up following operation, and death occurred within forty-eight hours in each case from shock and retrorectal infection.

The third patient was wounded by a fragment of shell in the left iliac fossa. The ileum was perforated in two places, the sigmoid colon was split longitudinally for two inches, and the rectum had a longitudinal laceration one and a half inches long in the anterior part of its upper third. Hæmoperitoneum was extensive. All wounds were oversewn at operation and the pelvis was drained, but the patient died twenty hours later.

The After-Treatment.—During the after-treatment in these cases of intestinal injury, post-operative paralytic ileus to a greater or lesser degree almost invariably occurred. Whenever this was severe the patients were toxic and restless, and lack of cooperation, despite adequate sedation with morphine, was in many cases evident. Often this type of patient could not tolerate his nasal tube, and the patient who repeatedly removed it against orders practically always died.

In other cases, after the vomiting had ceased and after the bowels had been freely open and the abdominal distention had disappeared, restlessness and toxicity were observed to persist, and even to increase despite daily bowel actions. This type of patient also almost invariably died, death occurring late, somewhere between the eighth and tenth days following operation. Whenever this sequence of events occurred, post-mortem examination disclosed the presence of retroperitoneal cellulitis.

The Bladder.—Sir Cuthbert Wallace, in his study of the figures in the Great War, found 16 deaths and one recovery and one in which the result was unknown in 18 complicated cases of bladder injury, whereas among 25 cases in which the bladder alone was injured, 11 patients recovered.

The figures for the bladder in this small series are shown in Table VII.

TABLE VII.

Extent of Wound.	Number of Cases.	Number of Patients Evacuated to Base.	Number of Deaths.	Mortality. (Percentage.)
Bladder alone	3	3	—	—
Bladder and other hollow abdominal viscera	2	—	2	—
Total	5	3	2	40

Small as this series is, it seems to confirm Wallace's findings that the outlook for men with bladder wounds depends on the presence or absence of accompanying wounds of other hollow viscera.

The practice was in all cases to suture carefully the rent in the bladder wall and to drain the bladder suprapubically with a de Pezzer tube. When intestinal injury was associated with the bladder wound the latter was sutured from inside the peritoneum after the gut had been dealt with. The bladder was then drained suprapubically and extraperitoneally.

Whether the bladder wound was intraperitoneal or extraperitoneal, it was thought desirable to retain the suprapubic tube until the initial wound and the excised missile track leading down to it had completely healed.

Wounds with Injury to Solid Viscera.

Conservatism was adopted in the treatment of wounds of solid abdominal viscera where it was certain that other organs had not been involved, provided no clinical signs or symptoms of severe or increasing concealed hæmorrhage were present.

In all the uncomplicated cases in this group in which operation was performed, signs of marked or progressive intraabdominal hæmorrhage were present, and in all cases laparotomy was performed when the slightest suspicion existed of superadded hollow viscus damage.

An estimate of the extent of solid viscus injury could be determined in many cases before operation by a consideration of the type of missile and its direction and by an estimation of its size from the X-ray screening. Bomb or shell wounds were found to produce the greatest damage, and patients thus injured were found to be more likely to require operation than those wounded by rifle or machine-gun fire.

The amount of damage to a kidney perforated by a bullet was often extraordinarily small, and beyond a transient hæmaturia for twenty-four to forty-eight hours no obvious ill effects were apparent. In all cases in which a kidney was injured with a small perforating missile, and in which no hollow viscus damage was superadded, conservatism was adopted and was followed by recovery.

Kidney.—The details of wounds in the kidney are shown in Table VIII.

TABLE VIII.

Extent of Wound.	Number of Cases.	Number of Patients Evacuated to Base.	Number of Deaths.	Mortality. (Percentage.)
Kidney alone	2	2	—	—
Kidney and hollow abdominal viscera	2	1	1	—
Kidney and other solid abdominal viscera ..	2	2	—	—
Kidney and thorax	3	2	1	—
Total	9	7	2	22

In this series, among nine patients with kidney injury nephrectomy was necessary in three cases only, and of the three patients two recovered to be evacuated to base.

Liver.—The details of wounds of the liver are shown in Table IX.

Seven patients with liver injury were treated; in only three of these was the liver injury uncomplicated by other visceral injury. In only one of

TABLE IX.

Extent of Wound.	Number of Cases.	Number of Patients Evacuated to Base.	Number of Deaths.	Mortality. (Percentage.)
Liver alone	3	3	—	—
Liver and hollow abdominal viscera	1	—	1	—
Liver and other solid abdominal viscera ..	1	1	—	—
Liver and thorax	2	2	—	—
Total	7	6	1	14

these three was laparotomy necessary, and at operation a large piece of the right lobe was found to be completely detached. The cavity remaining was lightly packed and recovery was uninterrupted.

Spleen.—The details of wounds of the spleen are shown in Table X.

TABLE X.

Extent of Wound.	Number of Cases.	Number of Patients Evacuated to Base.	Number of Deaths.	Mortality. (Percentage.)
Spleen alone	3	2	1	—
Spleen and hollow abdominal viscera	2	1	1	—
Spleen and other solid abdominal viscera ..	1	1	—	—
Total	6	4	2	33

The spleen was injured in six patients, and all showed pronounced symptoms of intraabdominal hæmorrhage on admission to hospital. In five of these cases splenectomy was carried out, three of the patients being ultimately evacuated to base. In the sixth case a laceration two inches long was found at operation, from which hæmorrhage had ceased. This splenic wound was sutured with interrupted mattress stitches, and the patient made a rapid recovery with an uninterrupted convalescence.

OBSTRUCTION OF THE ŒSOPHAGUS IN INFANTS AND CHILDREN, WITH REPORT OF SIX CASES.[1]

By P. L. Hipsley,
Sydney.

From time to time cases occur in infants or children in which there is either partial or complete obstruction to the passage of food through some portion of the œsophagus. Cases of atresia of the œsophagus have frequently been reported, and such cases have been studied exhaustively. In the *Archives of Surgery* recently,[1] in a symposium on the œsophagus, no less than twenty-four pages are taken up with a description of the various aspects of this condition. The incomplete obstructions, however, are not so well understood, and, when reported, the nomenclature used in their description is varied, because the actual cause of the obstruction seems to be obscure. In the symposium referred to above the only mention of these incomplete obstructions is one under the title of "Congenital Stenosis with Shortening of the Œsophagus", and the condition is dismissed with brief mention and the reproduction of two skiagrams. Different authorities have reported cases of this kind under the following titles: "The Congenital Short Œsophagus" (Clerf[1]), "Congenital Shortening of the Œsophagus" (Jacobie, Tweedie and Negus[2]), "Congenital Shortening of the Œsophagus, and the Thoracic Stomach Resulting Therefrom" (Findlay and Kelly[3]), "Congenital Dilatation of the Œsophagus" (Rotch[4]), "Congenital Stenosis of Unknown Origin" (Brown Kelly[5]), "Œsophageal Malformations and Strictures" (Villiers[6]), "Congenital Stricture of the Œsophagus" (Morse[8] and Hutchinson[7]), "Spasmodic Stricture of the Œsophagus with Fusiform Dilatation Above It" (Parkes Weber[9]), "Obstruction of the Œsophagus in Children" (Sheldon and Ogilvie[10]), "Disorders of Neuromuscular Coordination" (Langmead[11]), "Idiopathic Dilatation of the Œsophagus" (Bull[12]).

This varied nomenclature implies a variety of causes, but the similarity of the clinical features of the cases reported suggests that the ætiology is the same in each instance. It is possible, and indeed probable, that the underlying cause in all of them is a congenital narrowing, due to imperfect development of a section of the œsophagus similar to the narrowing sometimes found in other portions of the alimentary canal. If this assumption is correct, then the difference between these cases of stenosis and those with atresia is merely one of degree. I propose to make a survey of some of the cases already reported, to record another six cases, and to bring forward evidence to support the hypothesis that they represent different degrees of developmental anomalies of the œsophagus.

Atresia of the Œsophagus.

Atresia of the œsophagus is the most common type of obstruction, and is due to maldevelopment of the septum between the œsophagus and trachea. The proximal portion of the œsophagus is represented by a blind pouch, the extremity of which reaches a point between eight and ten centimetres from the lips. The distal portion of the œsophagus communicates with the trachea just above its bifurcation. (See Figure I.) Seven patients suffering from a lesion of this kind were admitted to the Royal Alexandra Hospital for

[1] Accepted for publication on April 14, 1942.

Children, Sydney, between November 25, 1936, and April 4, 1940. Cases are said to occur when both upper and lower segments of the œsophagus communicate with the trachea, and others when the upper segment only does so; but such varieties must be extremely rare.

Clinical Features.

The first food given is returned during feeding, and the infant becomes distressed and cyanosed. It is impossible to pass a rubber catheter for more than a few inches along the œsophagus. Owing to the communication between the lower segment of the œsophagus and trachea, air is present in the stomach. The infant generally dies in three or four days, but may live for ten or eleven days. All attempts to relieve the condition by operative interference have so far failed.

FIGURE I. Photograph of a specimen presented to the museum of the Royal Alexandra Hospital for Children by Dr. Ramsay Beavis. It is a typical case of atresia of the œsophagus, the proximal portion of which ends in a blind pouch, and the upper end of the lower segment communicates with the trachea. The folds of gastric mucosa can be seen extending upwards, and are continuous with similar folds in the œsophagus. The small rounded area about the middle of the stomach is a piece of aberrant pancreatic tissue.

STENOSIS OF THE ŒSOPHAGUS.

The stenosis which affects one centimetre or more of the œsophagus may be situated at the upper or lower orifice, near the middle, or at a point about two or three centimetres above its lower end, the commonest site being opposite the level of the seventh thoracic vertebra. The stenosis, when uncomplicated, is non-cicatricial in character, and varies from a slight narrowing to an almost complete occlusion.

Besides these cases, in which an appreciable length of the œsophagus is affected, there are others in which the obstruction is by a web or incomplete diaphragm.

Clinical Features.

The symptoms vary with the degree of obstruction. Even in the milder varieties of incomplete obstruction the infant may regurgitate some of its food during the first few days of life; but as the remainder passes into the stomach, the child will survive and may thrive. The regurgitation or so-called vomiting during the first few weeks frequently leads to the mistaken diagnosis of pyloric stenosis or of duodenal atresia; and a number of these patients have been unnecessarily operated on for these complaints. The food, however, usually returns without effort, and this usually occurs during and not after the act of feeding. In a few cases there has been a report of more forcible regurgitation, resembling somewhat the projectile vomiting of pyloric stenosis. A feature of diagnostic importance is that there is always a large amount of mucus in the returned food. Indeed the child may bring up mucus apart from the administration of food, and frothy mucus sometimes collects in quantity in the pharynx, and may have to be cleared out so as to free the airway of the child. The reaction of the returned food is alkaline, since it is not mixed with the acid secretions of the stomach. The infant either loses or does not gain weight to the same extent as a normal child. It is an interesting fact, however, that some of these infants, after the first

few weeks, gain weight regularly; and with careful feeding they may cease to regurgitate their food for months at a time. When attempts are made to change to a more solid food, the so-called vomiting returns, and the child may not be able to keep anything down for days at a time owing to the complete occlusion of the stenosed segment by a particle of solid food. One of the characteristic features of stenosis of the œsophagus is that there may be periods of severe vomiting, alternating with longer periods of freedom from symptoms. There is a real danger at this stage in attempting to investigate the cause of the trouble by the administration of a barium or bolus meal as is so often done, because the thick barium may block the œsophagus completely; and then attempts at feeding will result in some of the food getting into the air passage and causing bronchopneumonia, which is a not infrequent terminal event in these cases. There is also danger in attempting to investigate the condition or dilate the stenosis by means of bougies, as inflammation or possibly ulceration of the narrowed segment of the œsophagus may be produced, the symptoms thus being aggravated. Cases have been recorded in which symptoms of complete obstruction do not occur until later in life. There is little doubt that some of the patients die early in life with the condition unrecognized, as the regurgitation of food is thought to be vomiting due to some undetermined cause. In one of my own cases (Case I) the condition was not diagnosed until the child was two years and ten months old, although there was a history of so-called vomiting from soon after birth, and the condition was first diagnosed as pyloric stenosis. This child was fed entirely for ten years by means of a gastrostomy; and this was not finally closed until the patient reached the age of eighteen years.

Sheldon and Ogilvie[10] reported ten cases of œsophageal obstruction in children, whose ages ranged from nineteen months to eight years when first admitted to hospital, although in each case there was a history of vomiting from early infancy. Findlay and Kelly[3] report a number of these cases, the patients' ages ranging from four months to nine years when first admitted to hospital. Rotch[4] reported a case under the title of "Congenital Dilatation of the Œsophagus in a Female", and a post-mortem examination revealed some ulceration in the œsophagus below the obstruction. There appears to be an hereditary tendency to the condition, as a brother of Rotch's patient had a similar condition. This is the case reported by Morse.[8] As mentioned above, other authorities report similar cases under different titles.

Site of the Obstruction.

Keith[13] has collected a number of specimens from the medical museums of London which demonstrate the position and relative frequency of the various congenital obstructions met with in the œsophagus, and a summary of his findings is as follows:

1.	Non-cicatricial stenosis of the upper œsophageal orifice ..	9 cases
2.	Stenosis of the lower œsophageal orifice	6 cases
3.	Congenital stenosis of the mid-œsophagus	2 cases
4.	Malformations of the tracheo-œsophageal septum	14 cases

The fourth group is by far the most common, and most authorities agree that over 90% of all the congenital œsophageal obstructions belong to this group. Seven patients with lesions of this kind were admitted to the Royal Alexandra Hospital for Children, Sydney, in the four-year period between 1936 to 1940. In these cases the obstruction is complete and the condition is described as atresia. Congenital stenosis of the mid-œsophagus is much rarer, and Keith discovered only two such specimens amongst those in the medical museums of London. It may be, however, that this variety is commoner than the figures quoted above would indicate, because these are the cases that do not

always end fatally, as the degree of obstruction varies from complete atresia to slight narrowing; hence many of the patients may survive, and I believe that five of the six cases reported in this paper belong to this group. Keith, in the article referred to above, has illustrated this particular abnormality semi-diagrammatically, and I have reproduced his illustration in Figure II. This case is of great interest, as it helps in the interpretation of the cases reported in this paper and would seem to demonstrate the connexion between the atresias as illustrated in Figure I with the stenoses, skiagrams from which are shown in Figures III to XI.

Ætiology.

Atresia of the œsophagus is said to be due to maldevelopment of the tracheo-œsophageal septum. Congenital stenosis of the mid-part of the œsophagus is not so well understood. Keith[13] is of the opinion that this condition is allied to the atresias, but stated that "a satisfactory explanation of the condition has not yet been given". He also states that "it is certainly associated with an elongation of the œsophagus, which occurs during the development and growth of the lungs, and with the fact that in one stage of development (in human embryos of the second month) the œsophagus undergoes a temporary occlusion".

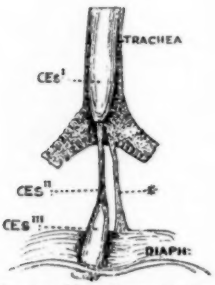

FIGURE II. Reproduction of an illustration from an article by Professor Arthur Keith in the *British Medical Journal* of February 5, 1910. This case seems to form a connecting link between the atresias and cases of stenosis similar to those described in this paper. It is a case of congenital stenosis of the œsophagus in a new-born child. ŒS[I]: the retrotracheal part of the œsophagus. ŒS[II]: the imperforate part. ŒS[III]: the supra-diaphragmatic part. *: muscular strand from the œsophagus to the right diaphragm.

As in other portions of the alimentary canal, where a temporary occlusion with subsequent canalization occurs, incomplete canalization may lead to the formation of a diaphragm or to a narrowing or in some cases to a complete obstruction of a segment of the œsophagus. In Case IV reported in this paper the obstruction was by a diaphragm at about the level of the seventh thoracic vertebra. In the other three cases there appeared to be a narrowing of a segment of the œsophagus at the same level. Cases have been reported in which an autopsy has demonstrated a marked stenosis due to a hard fibrous ring of tissue around the lower end of the œsophagus. Such cases have been reported by Hutchinson[7] and by Brown Kelly.[5] It may be that in these cases fibrosis has followed inflammation and ulceration in a congenitally narrowed segment. There is a large group of cases in which the obstruction is situated at about the level of the seventh thoracic vertebra, and in which the exact nature of the obstruction has been the subject of much speculation. They can be explained on the assumption that there is a congenital narrowing of a segment of the œsophagus, and I believe that this is the correct explanation. However, in the few cases in which an autopsy has been performed, no such narrowing could be found, and the theory of neuro-muscular incoordination has been put forward to explain them. The failure of these patients to respond to treatment which is recognized as the correct treatment of achalasia of the cardia, is evidence against this theory. Indeed, the attempted passage of mercury filled bougies nearly always aggravates the condition, a fact strongly emphasized by Sheldon and Ogilvie.[10] Some authorities, however, have succeeded in curing these patients by dilatation with bougies, as in cases reported by Morse.[8] Findlay and Kelly[3] have described a number of cases in which clinically there was obstruction in the lower portion of the œsophagus, and they have proved to their satisfaction that the portion of the food passage below the obstruction

was lined by gastric mucosa—in other words, that this portion was really stomach. I can find no evidence, however, of such a condition being confirmed by histological examination of a post-mortem specimen, and until such evidence is forthcoming the theory of congenital shortening of the œsophagus in these cases must be regarded as not proven. In the undoubted cases of congenital shortening of the œsophagus that have been reported, such as those by Myles[14] and another by Blasingame,[15] very few symptoms occurred during life. Two of the cases were accidentally discovered in dissecting room specimens, and two others were discovered by X-ray examination of patients, aged fifty-three years and seventy-six years respectively. In the two post-mortem specimens the portion of the stomach above the diaphragm occupied a prolongation upwards of the abdominal cavity which was lined by peritoneum, thus resembling cases which have been described as diaphragmatic hernia, and differing entirely from the cases under consideration in this paper.

In one of my own cases (Case II), Dr. Milton Coutts, who made an examination with an œsophagoscope, reported that the mucosa of the food passage below the obstruction was indistinguishable from gastric mucosa; but no biopsy was made to prove that such was the case. In Figure I, which is a typical case of atresia, it will be seen how closely the mucosa below the obstruction resembles gastric mucosa. The folds of gastric mucosa extend right up to the upper end of the obstructed œsophagus. A microscopic examination from this specimen revealed that there was no gastric mucosa above the level of the ill-defined and very widely open cardia, although to the naked eye the stomach appears to begin just below the bifurcation of the trachea.

Treatment.

The condition should be investigated by means of an œsophagoscope, and if a diaphragm or web is present, this should be divided and the œsophagus dilated; but when there is a severe degree of stenosis of a segment of the œsophagus due to a congenital narrowing, attempts at dilatation are not always advisable. The history of most of these patients shows that regurgitation of food occurs from a very early period of life, generally from the first few days, but some food enters the stomach and the child may continue to thrive until attempts are made to give more solid food. The condition may be aggravated by the injudicious passage of bougies, which may cause inflammation, ulceration and spasm of the stenosed segment of the œsophagus. The administration of a thick barium meal may lead to a complete blockage, followed by inanition and death, usually preceded by bronchopneumonia due to entry of some of the food into the air passages when attempts have been made to feed the child when the œsophagus is obstructed with barium. If care is taken to give only liquid food in small quantities, the child will thrive, and if regurgitation recurs when attempts are made to give thicker food, then a return should be made to liquid food.

In time the narrowed portion of the œsophagus will gradually enlarge and reach a size at which solid food can be taken. In one of my own cases (Case I) the patient reached the age of eighteen years before she could deal with solid food. This was an extreme case, and possibly if she had been kept under observation longer, after the gastrostomy, she would have been able to swallow solid food at a much earlier period. When complete obstruction has occurred, owing to one of the causes mentioned above, then it may be necessary to perform a temporary gastrostomy and feed the child by this means until the ulceration and superadded spasm have disappeared. Of the three cases reported in this paper in which gastrostomy was performed, in two of them the opening was allowed to close within a few months, and in

the third it was closed after the stomach was dissected free from the abdominal wall when the gastrostomy had been in existence for fifteen years.

It is possible that in the milder degrees of stenosis dilatation may hasten recovery, and a number of cases have been reported in which such treatment has been effective. Morse[8] reports two such cases. One can understand such treatment being successful when an incomplete diaphragm is present, but when there is a narrowing involving all the coats of the œsophagus, attempts at rapid dilatation must inevitably fail. In my own cases when gastrostomy had been performed I succeeded in getting the child to swallow a length of silk thread with a leaden shot attached, and then by hooking the thread through the gastrostomy wound and attaching a rubber catheter, I was able to draw the catheter through the obstruction. In each case this always passed readily from below upwards, whereas all attempts to pass the same sized catheter without the silk thread attached from above downwards invariably failed. I did not find, however, that this treatment had any effect in hastening permanent improvement.

REPORT OF SIX CASES.

Case I.

F.T., a female patient, aged two years and ten months, was first admitted to the Royal Alexandra Hospital for Children, Camperdown, in February, 1925. Her weight at that time was only fifteen pounds, and her birth weight was stated to have been eight and one-half pounds.

She had had frequent attacks of so-called vomiting, which commenced with her first breast feed, and had continued with short intermissions up to the time of her admission to hospital. At first, in spite of the absence of any visible peristalsis, the condition was thought to be due to pyloric stenosis, and she had been treated with belladonna, and was said to have had gastric lavage. The subsequent history of the case casts a doubt on the possibility of this procedure, because whilst the patient was in hospital it was never possible to pass a catheter through the obstruction in the lower end of the œsophagus. When the patient was three months old her weight had fallen to six pounds, and at twelve months she weighed only ten pounds. At this time the vomiting lessened somewhat, and periods of three or four days would elapse without any vomiting, and then it recurred with increased intensity, especially if she attempted to swallow anything solid, and an attempt to swallow even a few breadcrumbs would bring on the attacks. She first walked when one year and ten months old. At the age of two years and four months she weighed twenty-four pounds, and was admitted to Kempsey Hospital for one month. Whilst she was there her weight steadily decreased, as she seemed unable to retain any food at all, and even a drink of water might start her vomiting. When admitted to the Children's Hospital she was so weak and emaciated that she was unable to move her limbs, and was barely able to roll her head from side to side. A gastrostomy was performed, and feeding by this means produced such a remarkable change in her condition that after six months her physical and mental condition became almost normal for her age. Soon after the gastrostomy operation an opaque meal revealed an obstruction in the lower segment of the œsophagus at about the level of the seventh thoracic vertebra. The skiagram after an opaque meal is shown in Figure III. Within a week of the operation the child was able to swallow some food given by the mouth, such as porridge, cream, milk and biscuits; and she gained one pound per week for three weeks. For a time she was fed partly by mouth and partly by means of the gastrostomy opening. She remained in hospital for sixteen

FIGURE III. Skiagram (lateral view) in Case I, showing œsophagus markedly dilated above an almost complete obstruction at level of seventh thoracic vertebra. A gastrostomy was performed in this case and the catheter can be seen in the stomach.

months, and during this period there were times when she took most of her food by the mouth and at other times she had to be fed solely by means of the gastrostomy opening. Several unsuccessful attempts were made to pass a number 15 Jaques soft rubber catheter through the obstruction from above, and on several occasions the same catheter was drawn upwards through the obstruction from below. This was accomplished by getting the child to swallow a leaden shot clamped onto the end of a silk thread. The thread was drawn through the gastrostomy opening by means of a small hook made by bending the end of a probe. The catheter could be drawn through the obstruction in this way in either direction, and its easy passage proved that there was no spasm gripping it anywhere along the œsophagus. After sixteen months in hospital the child returned to her home in the country, and was still being fed mainly by means of the gastrostomy opening. We saw nothing more of her for fifteen years, at the end of which time she was sent back to me to have the gastrostomy wound closed.

FIGURE IV. Antero-posterior skiagram in Case I taken when patient was eighteen years of age—that is, fifteen years after skiagram shown in Figure III, and a few days before the closure of the gastrostomy. There is still a slight degree of narrowing of the segment of œsophagus at level of seventh thoracic vertebra.

FIGURE V. Lateral skiagram in Case I taken at same time as that shown in Figure IV.

She said that for ten years after returning home she was fed solely by means of the gastrostomy opening. Then she found that she could manage to swallow liquid food, and so for the next five years she subsisted on such food taken by the mouth. For the last six months she found she could swallow solid food quite well. A few weeks ago I closed the opening in the stomach after freeing it from the abdominal wall. The gastrostomy had at this time been in existence for fifteen years. Before the opening was closed the condition of the œsophagus was again investigated by X-ray examination after a barium meal, and by the passage of a large sized mercury-filled bougie, and no obstruction was revealed or encountered by these means. One other noteworthy feature of this case is that at the age of nine years, owing to her clothes catching fire, she suffered from a very severe burn involving the whole of the anterior aspect of the abdomen and part of the chest and thighs. This necessitated confinement to bed in her own home for a period of two years, and she will require further operative treatment to deal with the extensive scarring. In spite of all these burdens, necessitating such an invalid existence for most of her life, she appeared to be a perfectly normal, happy and contented girl with never even a whisper of complaint about her misfortunes. The X-ray photographs taken immediately before the closure of the gastrostomy are shown in Figures IV and V. There still appears to be some narrowing of the œsophagus at the level of the seventh thoracic vertebra, but it was not sufficient to prevent the swallowing of solid food.

Case II.

B.M., a male patient, aged seven months, was admitted to the Royal Alexandra Hospital for Children on March 11, 1940. The mother stated that the child had weighed

seven pounds and eleven ounces at birth, and lost twelve ounces during the first eight days because he always brought up a little of each feed. This was thought to be due to overfeeding, although a test meal did not confirm this. As the quantity of food was increased to comply with his age requirements, so the vomiting increased; and although at this time he took the full amount, there were other occasions when he refused half the amount given. He frequently brought up a lot of mucus with the food. In spite of these mild attacks of vomiting, the weight steadily increased, and when thirty weeks old he weighed fourteen pounds twelve ounces. At this stage the vomiting became severe and persistent and he rapidly lost weight. An unsuccessful attempt was made to pass a number 15 soft rubber catheter into the stomach, and an attempt to pass a mercury-filled bougie also failed. His general condition became rapidly worse, and a continuous intravenous drip administration of saline solution was

FIGURE VI. Lateral skiagram in Case II. It shows the constriction in the lower end of the œsophagus, with dilatation above. A gastrostomy was done in this case and the catheter can be seen in the stomach.

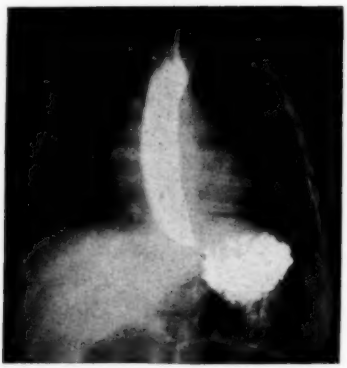

FIGURE VII. Antero-posterior skiagram in Case II, showing the constriction at the lower end of the œsophagus. Some of the barium has entered the stomach.

commenced, and gastrostomy was performed on April 9, 1940. All attempts to pass a catheter into the stomach by the mouth failed, but by use of a method similar to that employed in Case I, a catheter was drawn through the obstruction from the stomach end without any difficulty.

An X-ray examination after an opaque meal revealed delay in the passage of the meal through the lower end of the œsophagus and some dilatation of the œsophagus above the obstruction. The skiagrams are shown in Figures VI and VII. The child remained in hospital for nine months. During this time he was fed for a period of six months mainly by means of the gastrostomy opening. About this time also he nearly succumbed to an attack of bronchopneumonia. For the last three months he has taken most of his food by mouth, provided it is in liquid form; and the gastrostomy wound has now been allowed to close. An œsophagoscope was passed on two occasions in this case by Dr. Milton Coutts, who reported as follows:

"There is no definite cardiac sphincter present. The cardiac orifice is widely open. Gastric folds appear at seven inches, and definite gastric mucosa is present at seven and one-half inches from the lower teeth."

The absence of a cardiac sphincter was also noticed by myself both in this case and in Cases I and III, in all of which gastrostomy was performed, and an examination could be made by the insertion of a finger through the cardiac orifice. It will be noticed also that there is an absence of the sphincter in the case of atresia shown in Figure I.

Case III.

K.B., a male patient, aged nine months, was admitted to the Royal Alexandra Hospital for Children on May 4, 1939. The child had been treated for hæmorrhagic disease of the newborn when a few days old, and had been operated on as though

suffering from pyloric stenosis when six weeks old. He had had attacks of vomiting since birth until the operation for pyloric stenosis. The mother stated that the child vomited several times a day for the first six weeks; her description was "for the first six weeks he was always very hungry, and stopped about a quarter-way through his bottle, looked upset and very uncomfortable, then without warning he would vomit back his food in a fountain-like fashion". Dr. Tait, who performed the operation, said that he did not find the amount of thickening of the pylorus usually seen in such cases, but there was a definite constricting layer of fibrous tissue present, which he divided as is done in the Rammstedt operation. The child remained fairly well after this operation and did not vomit again for about six weeks. During this time, although able to take his food, he did not put on any weight; and then one day without warning he commenced to vomit again and, according to the mother, "in exactly the same manner

FIGURE VIII. Antero-posterior skiagram in Case III. The barium bolus was completely held up at almost the level of the seventh thoracic vertebra. The œsophagus remained completely blocked for several days. Gastrostomy was performed and the catheter can be seen in the stomach.

FIGURE IX. Lateral skiagram in Case III, after administration of a barium bolus which blocked the œsophagus, necessitating gastrostomy.

as before the operation". When nine months old he was readmitted to the Royal Alexandra Hospital for Children. He had been vomiting persistently for about two weeks, and always brought up a large amount of mucus. Several unsuccessful attempts were made to pass a soft rubber catheter into the stomach. After a few days in hospital he again began to swallow liquid food without difficulty, and gained weight regularly for a few weeks. He was given a barium meal and this revealed an obstruction in the lower end of the œsophagus. The appearance of these skiagrams shown in Figures VIII and IX rather suggested that the barium had entered a congenital pouch, but the subsequent history excluded this possibility. After the barium meal it was impossible to get the child to swallow any food for several days, and the barium remained blocking the œsophagus during this time. An attempt at examination with an œsophagoscope also failed, partly because of the presence of the barium and partly on account of the presence of a large amount of mucus. The condition of the child became critical, and a gastroscopy was performed on June 27, 1939. He was fed entirely by this means for several weeks and his condition rapidly improved. At the time of the operation a finger could be passed into the lower end of the œsophagus and one noted the absence of any definite cardiac sphincter. On several occasions a large size rubber catheter was drawn upwards through the œsophagus, the same method being used as in the other two cases; but it was never possible to pass the same catheter through the obstruction from the proximal end. The child was fed mainly by means of the gastrostomy for several months, and then liquid food was given by the mouth and was swallowed without difficulty. The gastrostomy was then allowed to close. The child is putting on weight regularly, and on January 29, 1941, weighed thirty-five pounds. He vomits occasionally after taking solid food, but the mother says that he can eat bread, cakes, vegetables, puddings, ice-cream, chocolates *et cetera*.

Case IV.

M.C., a male patient, aged thirteen months, whose birth weight was seven pounds, on admission to the Renwick Hospital weighed sixteen pounds and fourteen ounces. There was a history of intermittent vomiting since birth. The mother stated that there was always a lot of mucus at the back of the throat, which had to be cleared out frequently. Whilst in hospital the child could swallow liquid food, but anything more solid was vomited, and the vomitus contained a lot of mucus. An X-ray examination after a barium meal revealed a narrowing of the œsophagus at a point about two centimetres above the diaphragm, but there was no gross dilatation of the œsophagus above the obstruction.

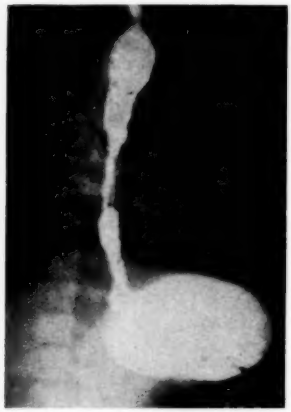

FIGURE X. Lateral skiagram in Case IV. A constriction is seen near the lower end of the œsophagus, which in this case was said to be due to a web or incomplete diaphragm. Some of the barium has entered the stomach.

Dr. Milton Coutts, to whom I am indebted for these notes, made an examination with an œsophagoscope. By the use of a Jackson's five-millimetre bronchoscope the upper part of the œsophagus was easily entered and was found to be wide enough to take a seven-millimetre tube. There was a diaphragm across the lower end of the œsophagus with an opening about two millimetres wide near its centre. The mucous membrane of the œsophagus above the diaphragm was irregular, with folds in the long axis. The opening in the diaphragm was dilated with forceps, a small piece of shaggy mucous membrane being left on the wall of the œsophagus. A smooth swab holder was then passed through and beyond the area of the stricture. The œsophagus was now widely open and the bronchoscope passed through and beyond the stricture without difficulty. The condition of the child improved after the dilatation, but he developed pneumonia and died ten days later. No post-mortem examination was made. The skiagram taken before the dilatation is shown in Figure X.

Case V.

F.N., a male patient, aged four years, was admitted to the Royal Alexandra Hospital for Children, Sydney, on December 16, 1941. He was a thin, anæmic child, weighing two stone two pounds. He commenced to vomit soon after birth. The vomiting generally occurred during feeding; and the mother stated that if a feed was not vomited at once, it would not be vomited at all, showing that once it had passed into the stomach it stayed there. The child was always hungry, although it gained weight fairly regularly. The weight chart from the health centre, which the mother had fortunately retained, is reproduced in Table I. It shows that except for an initial fall in weight from birth up to the end of the second week, the infant gained in weight quite regularly for the first two years.

TABLE I.

Case V: Weight Chart of Patient—Birth Weight was Seven Pounds.

Age.	Weight in Pounds and Ounces.	Age.	Weight in Pounds and Ounces.
2 weeks.	6 13½	31 weeks.	15 12
2½ weeks.	7 1	32 weeks.	15 14
4 weeks.	7 8	35 weeks.	16 2
5 weeks.	7 10½	37 weeks.	16 10
6 weeks.	7 13½	38 weeks.	16 12
8 weeks.	9 6	39 weeks.	17 0
9 weeks.	9 14	40 weeks.	17 2
10 weeks.	10 7	42 weeks.	17 6
13 weeks.	11 2	43 weeks.	17 12
14 weeks.	11 8	45 weeks.	17 10
15 weeks.	12 5	50 weeks.	18 8
17 weeks.	13 0	51 weeks.	19 0
19 weeks.	13 9½	14 months.	19 12
20 weeks.	14 5	16 months.	21 12
24 weeks.	15 10	1 year 8 months.	22 12
30 weeks.	15 12	2 years.	23 3

The mother said that for the first twelve months the child vomited some portion of almost every meal. By a study of the weight chart it is obvious that most of the food taken must have reached the stomach until the child was two years old. At this stage solid food was added to the diet, and the vomiting became more pronounced and persistent. On one occasion the child took a small piece of carrot from his sister's plate and after this he vomited everything for three days. He then vomited the piece of carrot, and the vomiting ceased as long as he was kept on liquid food. Dr. Milton Coutts and Dr. Ramsay Beavis have both investigated the condition of this child's œsophagus by means of an œsophagoscope, and graduated œsophageal bougies were carefully passed through the obstructed segment without an attempt at forcible dilatation. The skiagrams of this case are seen in Figures XI and XII.

FIGURE XI. Lateral skiagram in Case V. The œsophagus is considerably dilated above the level of the obstruction.

FIGURE XII. Lateral skiagram in Case V taken twenty-four hours after dilatation with bougies.

Case VI.

S.T., a female patient, aged four and a half years, was admitted to the Royal Alexandra Hospital for Children, Sydney, on January 12, 1942. She was a rather

FIGURE XIII. Antero-posterior skiagram in Case VI. The œsophagus is greatly dilated above the obstruction which is at the level of the seventh thoracic vertebra.

FIGURE XIV. Lateral skiagram in Case VI taken at the same time and showing the same features as Figure XIII.

spare and pale child. She had had attacks of vomiting since birth. The vomiting was said to be quite forcible at times, resembling projectile vomiting. The birth weight was seven and a half pounds. When twelve days old the patient was operated on as a probable sufferer from pyloric stenosis. The operation was done after investigation by means of a thin barium meal which passed readily into the stomach. At operation some thickening of the musculature of the pyloric antrum was seen, but the case was not one of pyloric stenosis; and as the opaque meal showed that there was no abnormality in the duodenum, small or large bowel, the child returned to the country. The subsequent history of this patient was very similar to that in Case V. On one occasion, however, the child vomited some dark blood and later had melena. When the patient was admitted to hospital a few weeks ago the cause of the vomiting was revealed by the giving of a barium bolus, which was held up at the level of the seventh thoracic vertebra, and above this level the œsophagus was dilated. The skiagrams of this patient are seen in Figures XIII and XIV. Dr. Ramsay Beavis has investigated this case by means of an œsophagoscope. The stenosed segment of the œsophagus appeared to have more rigid walls and was much more resistant to dilatation than the œsophagus in Case V.

SUMMARY.

Mention is made of the varied nomenclature used in the descriptions of cases of œsophageal obstruction in children, which suggests that the ætiology is obscure.

Atresia and stenosis of the œsophagus are described, with their symptomology and treatment.

The case histories of six more patients with congenital obstruction of the œsophagus are described.

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THE QUESTION OF EXCISION AND SUTURE OF WOUNDS IN WAR SURGERY.[1]

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THAT war is a wasteful procedure is a fact that permits of no argument, but in many ways useful lessons can be learned and progress in many directions made under the stimulus of war. The present war is no exception, and there is no reason why medical science should not receive a maximum benefit, provided initiative is encouraged and developed and opportunity is grasped, not only for coordination of the personal experiences of those actively engaged with problems in each field of war, but also for those in authority ultimately to postulate the broad principles to be followed and the specific conditions necessary for success in various forms of treatment, medical or surgical.

This was done both during and after the 1914-1918 war, and traumatic surgery made some great advances which later were applied to the problems of civil life. In particular one may mention the treatment of head, chest, joint and soft tissue injuries with and without fractures. During 1916 and 1917 the technique of excision of wounds and either primary or delayed primary suture was evolved by a large number of surgical teams (one of which included the writer) working under the direction of an Army consulting surgeon, until finally the detailed technique became standardized.

Provided the necessary conditions could be adhered to and all other circumstances were favourable, this method of treatment of wounds resulted in an extraordinary reduction in time spent in hospital by great numbers of wounded. The principles laid down received world-wide application in civil surgery, and for twenty-five years this technique has stood the test and has been approved by all who used their intelligence in its application.

It was for these reasons that the article by Colonel W. A. Hailes on "Excision and Primary Suture of Wounds in War Surgery", published in THE AUSTRALIAN AND NEW ZEALAND JOURNAL OF SURGERY, July, 1942, was turned to with eager anticipation, and especially since several articles dealing with personal experiences had already been published by surgeons within his command. It was expected that some crystallization of the experiences of Australian surgeons in the Middle East would have been presented, but apart from a general condemnation of this established procedure in its application to mobile warfare, no new facts emerged and criticism of the present writer was made under an obvious misunderstanding of his remarks. Colonel Hailes overlooked the several warnings given: that such methods "are not work for the untrained or occasional surgeon"; also, "wound excision must be carried out with meticulous care by a deft surgeon working under the best aseptic conditions possible"; and, "to close an inadequately excised wound is to subject the patient to a very grave risk of sepsis which may imperil his life". The theme of perfection enunciated can seldom be attained under the field conditions of the warfare of today. The adoption of excision and primary suture of wounds under conditions of mobile warfare was not advocated, and it was thought this would have been very evident

[1] Accepted for publication on September 28, 1942.

to readers; but apparently it was not. In the leading article in this journal, Volume xi, Number 3, January, 1942, over the name of the present writer, it was stated: "Owing to the difficulties in collecting wounded in mechanized warfare and the delay in bringing them to efficient surgical units, the primary suture of wounds as practised in the last war can seldom be employed. . . . For a similar reason *débridement* takes on a new meaning and must have only a limited application."

Colonel Hailes's antagonism to such an established and widely practised technique is based solely on his experiences in the Libyan and Syrian campaigns, both of which were rather limited fields of action, where conditions for surgery of any kind were mostly bad. Under such conditions it was a wise precaution to prohibit the employment of this technique; but is it wise to prohibit it altogether and in such drastic fashion as to lead Colonel Hailes to "warn all who may have been stimulated by these surgical measures and intend to put the principles enunciated into practice, that, while the surgical section of the Medical Directorate is at present constituted, such action will assuredly cost them their surgical positions" and for him to remark that "the casualty clearing station surgeon should be unaware that such a procedure is possible"?

Such a total prohibition of an established surgical technique which was developed under war conditions will deny to many of our wounded men the benefits which they should receive, provided they are situated under such conditions as would permit practice of the full procedure by a competent surgeon.

In the Director of Medical Services instruction (March, 1941) it is recommended that "after excision all wounds be left open and no attempt be made to suture the wound except in cases of G.S.W. of the skull, thorax, abdomen and large superficial joints such as the knee joints". If excision and primary suture is allowable in the areas mentioned, it should be carried out only provided conditions are favourable for aseptic surgery and the patient has been brought to an efficient surgical unit before infection has supervened—that is, within six to eight hours of wounding. If it is allowable in the vitally important areas mentioned, why exclude it for soft tissue wounds? The present war has proved to be unique not only as to methods of warfare but in the fact that it is a "total war", and the civil population is just as likely to receive war injuries as are those actually engaged in the fighting services.

There is a very large body of medical men who are concerned in making provision for civilian casualties and who incidentally are concerned also in the training of both undergraduates and recent graduates. It is their duty to take a wide and dispassionate view of all surgical procedures likely to benefit patients who now come under their care or who may do so should any direct attack be made by the enemy on our towns or cities. Consequently our civilian surgeons must weigh carefully any opinions from individuals whose experience is confined to a foreign terrain of limited extent. During 1940 and 1941 those engaged in training medical students and graduates had to rely on general principles based on experience in the Great War and on their application in civil practice, because, except for letters from friends overseas, no channel of communication was opened up until several articles appeared in our own journal this year and a few from other surgeons in the current periodicals. It would be not only a courteous gesture, but a very helpful one to everybody, if copies of all memoranda or circulars issued by the Medical Directorates of the Commonwealth Forces were forwarded to the various medical schools, teaching hospitals and teaching bodies in both

Australia and New Zealand. It would ensure that spirit of cooperation and understanding which we should all wish to achieve.

In order to remove any possible misunderstanding as to the application of the technique of excision and primary or delayed suture of wounds, it seems advisable to state plainly the conditions necessary for success in this procedure.

1. It should not be attempted by any but a skilled surgeon.

2. An operating theatre must be available where strict asepsis can be maintained by a staff of competent assistants.

3. It is essential to receive the patient within eight hours at most from the time of wounding.

4. When there has been extensive damage to or loss of soft tissues the procedure should not be attempted.

5. Thorough excision of all damaged or devitalized tissue must be practised and absolute hæmostasis obtained.

6. No buried sutures should be employed other than to close serous membranes. Suturing should be done with unabsorbable material, deep bites being taken in the tissue and the sutures being tied without tension.

7. If sulphanilamide powder is available the wound should be dusted with it before being closed.

8. If there is any doubt at all as to closure, it is wiser to use sulphanilamide and to cover the wound with "Vaseline" gauze. Never pack wounds tightly.

9. Because of the impossibility of securing the complete excision mentioned in paragraph 5, this technique is not to be employed in the presence of comminuted fractures.

J. Paterson Ross, writing in the *British Medical Journal* of May 9, 1942, states:

> The best safeguard against infection of a wound is early excision, and if this is thoroughly performed and the surgeon is satisfied that he has been able to reach and remove all the devitalised tissue, the wound may be closed completely, either with or without the local application of an antiseptic. Primary closure of a wound is the best safeguard against secondary infection, and provided the patient can remain under the care of the surgeon who undertakes the operation it should be possible to adopt this method of treatment for most wounds involving only skin and muscle. In exceptional cases it may be possible to close wounds even when a fracture has occurred, but it will usually be best to leave such wounds open.

At first sight the proviso he makes as to the patient remaining under the care of the operating surgeon seems to accord with Colonel Hailes's remark that primary suture should imply undivided responsibility, but the reasons given in each case are widely different. Whether recent wounds are sutured or not, the importance of the excision or *débridement* cannot be stressed too highly, as the ultimate fate of the patient depends on the control of sepsis.

Trueta, in discussing what has come to be known as "the closed plaster technique", goes so far as to state that "the keystone of the whole technique on which success ultimately depends" is proper excision and that without it the technique is worthless or even dangerous. This is mentioned specifically, as in most large wounds of the limbs it is desirable to use this method until such time as the patient can reach a base hospital.

Before this short paper is concluded there are two small matters mentioned by Colonel Hailes which require explanation. First with regard to the Thomas splint: the use of a clove hitch in maintaining extension was intended, as has been indicated by Colonel Hailes, for use "only as far back as the main dressing station", where some more efficient means of extension should be applied. As to the use of a plaster spica in preference to the Thomas

splint, one of our surgeons still in the Middle East and attached to a large British base hospital writes under date July 8, 1942:

> Experience has confirmed the superiority of the treatment of compound or simple lower limb fractures by the Thomas splint—skin traction *plus* plaster for travelling purposes; Thomas splint *plus* movable skeletal traction for permanent fixation; the importance of fixation and the unimportance of reduction of fractures in forward operating units.

The other point was regarding the blood concentration in the use of sulphonamides when two milligrammes *per centum* was mentioned as the optimum: this should have been corrected to read as the minimal concentration. The use of sulphonamides, and in particular the local use of sulphanilamide in wounds, has received a most striking justification in the Pearl Harbour report. In regard to the use of tablets not being as efficient as the powder, this is hardly borne out in practice, and reference as to the whole question should be made to the excellent article by T. E. Wilson in THE AUSTRALIAN AND NEW ZEALAND JOURNAL OF SURGERY, Volume xii, Number 1, July, 1942, at page 34.

Case Reports.

PERIPHERAL ANEURYSMS OF TRAUMATIC ORIGIN: CASES OCCURRING IN BRACHIAL, RADIAL AND ULNAR ARTERIES.[1]

By Douglas Robb, W. R. McKechnie and D. W. Guthrie,
Auckland, New Zealand.

Details of these cases are recorded as being relevant in these days of trauma and when the behaviour of the peripheral circulation under difficulties is of particular interest. One of us recently described a similar aneurysm in the popliteal artery.(1)

Case I.—Traumatic Aneurysm of Left Brachial Artery.

(D.R.)

Mr. S.K., aged fifty-three years, a Dalmatian, referred by Dr. A. J. Brass, was struck in the left antecubital space on September 2, 1941, by some flying fragments of metal from a chisel. There was very severe bleeding, checked with difficulty in hospital. X-ray examination showed some tiny fragments remaining. Soon after the wound healed, a small pulsating swelling was noticed. This had steadily increased, and the only other symptoms were recent loss of power in the forearm and some pain.

On examination on February 24, 1942, there was a scar half an inch long in the left antecubital space overlying the lateral aspect of a pulsating expansile swelling the size of a walnut. The centre of this swelling lay opposite the internal epicondyle. There was no loss of sensation or muscular action, though the grip was weaker than on the right side. The veins of the forearm were more prominent than usual, but did not pulsate. There was pain in the arm, passing upwards from the swelling.

Operation on March 3, 1942, was carried out under general anæsthesia without a tourniquet. An attempt the evening before to infiltrate the sympathetic nerves to the limb below the necks of ribs one, two and three with "Proctocaine" had failed. The swelling was defined by dividing the *lacertus fibrosus*, and a loop of smaller rubber tube passed around the artery both above and below the swelling. The latter manœuvre was difficult at both sites because of the tough adhesions of *venæ comites* to the artery and aneurysm, and the difficulty of being certain that other tissues such as nerves were not involved. The enucleation of the aneurysm gradually became easier and was finally complete, the *venæ comites* being retained intact. Two and a half centimetres of artery were resected, bearing the aneurysm, and the upper and lower ends of remaining artery were doubly ligated with number five plaited silk.

The wound healed uneventfully. At no time was there anxiety about the circulation in the forearm and hand. For the first two days the radial pulse could scarcely be felt, though the hand was very hot. Later the pulse increased, being almost equal to the other side at fourteen days. Along with this a certain amount of coldness was complained of and the hand felt cold. All movements were present and strong throughout.

The aperture into the sac, which was a lateral one, from the lumen of the artery, was about three by two millimetres in the fixed specimen and had smooth edges. The *tunica media* could be seen and traced completely round the sac in the half section. The sac was filled completely with tough laminated clot.

Case II.—Traumatic Aneurysm of Radial Artery.

(W.R.McK.)

S.W., a male, aged eighteen years, had pierced his forearm with a butcher's knife six weeks previously. There was true arterial spurting, which was controlled by a tourniquet on the upper arm and by local pressure. Eight or nine days later the patient noticed a lump about one centimetre from the scar. During the week following it steadily increased in size, but after that time it remained stationary. The lump ached frequently, but did not interfere with his work. He applied for treatment with the request for "lancing my abscess".

[1] Accepted for publication on April 24, 1942.

On examination there was an oval pulsatile swelling the size of a walnut on the palmar aspect of the forearm, opposite the level of the insertion of *musculus pronator radii teres*, in the line of the radial artery. Aneurysm was diagnosed and excision advised.

A generous incision was made, no tourniquet being used. The fascia was divided between the pronator and brachioradialis muscles, and the latter was retracted laterally. The radial artery was found, the superficial division of the radial nerve lying laterally to it. Tapes were passed around the artery above and below the swelling and held in forceps.

The dissection of the aneurysm from the surrounding tissues was fatiguing and troublesome, owing to fibrosis and scarring. It was found impossible to free and preserve the *venæ comites*, but the superficial division of the radial nerve was saved with difficulty. The artery was tied above and below the aneurysm with number three chromicized catgut, Ballance's stay knot being used, and the aneurysm was removed without rupture. The wound was closed with continuous dermol, and a plaster was applied to the forearm.

There was no anxiety about the circulation. For at least three days the hand was hot, and then returned to normal temperature. Plaster and stitches were removed in ten days and the patient was discharged from hospital.

The specimen revealed a fusiform aneurysm, the artery entering and leaving at opposite ends. Portions of *venæ comites* were found adherent to it. In the fixed specimen the length of artery removed was 5·5 centimetres, the dimensions of the sac being 2·5 by 2·0 centimetres. Most of the sac was filled with recent laminated clot, but there were thin inspissated layers adherent to the intimal lining.

Case III.—Traumatic Aneurysm of Ulnar Artery at the Wrist.

(D.W.G.)

The patient, a girl five years of age, fell with the hand outstretched on a broken bottle. Fairly severe bleeding occurred from a puncture wound just lateral to the pisiform bone. This was controlled by a suture in the casualty department.

Fourteen days later a pulsating swelling was noticed under the wound, which, according to the mother, had not healed well and had shown a tendency to ooze when the suture was removed. The patient was admitted to hospital and the suspected diagnosis was dramatically confirmed by rupture of the aneurysm in the ward—possibly because of efforts to elicit pulsation.

When the patient was first examined (after the aneurysm had ruptured and with a tourniquet controlling the hæmorrhage but causing great pain), a lesion of the ulnar nerve was suspected, but confirmation was left until operation, as it was thought best to replace the tourniquet with a local pressure bandage.

Under general anæsthesia an incision was made along the line of the artery just lateral to and centred on the pisiform bone, the hæmorrhage being controlled with a sphygmomanometer cuff. Laminated clot was wiped away and the artery identified and ligated proximally and distally.

The ætiology was plainly seen to be the usual finding—a transverse cut partly severing the artery. The ulner nerve was seen to be divided about one millimetre above its bifurcation; it was sutured with the tourniquet released because it was felt that the use of a tourniquet in the ward prejudiced its further use for more than the few minutes required to deal with the aneurysm.

The writer has twice before dealt with aneurysms of the ulnar at the same site; both were caused by a fall on glass with the hand outstretched. The first was diagnosed without careful examination as fibrous tissue around a piece of buried glass and the true position was discovered on exploration. In the light of the first, the second case was correctly diagnosed.

Formed under dense tissue, these aneurysms tend to be small. From personal experience they would also seem to be not uncommon. This can be readily understood when it is considered how easily the artery and the nerve are damaged at this site, being unable to slip aside because they are confined to the fibrous tunnel formed by the *ligamentum carpi volare*.

Reference.

(1) Douglas Robb: "Successful Resection of a Popliteal Aneurysm of Traumatic Origin", THE AUSTRALIAN AND NEW ZEALAND JOURNAL OF SURGERY, January, 1940, page 314.

SANDWICH RADIUM MOULDS APPLIED TO NASAL NEOPLASMS.[1]

By P. D. Braddon,

Sydney.

These three cases are reported in order to demonstrate the great value of bilateral radio-active fields, applicable in many ways, but, in this series of cases, confined to growths in different nasal regions. It is, of course, well known that intensity of dosage from the γ rays of radium falls off rapidly in depth. This has obvious advantages in the treatment of flat areas and growths of relatively limited thickness or infiltration, but for thicker or deeper lesions it becomes a disadvantage, which may, however, be overcome by the use of bilateral radio-active fields. These may be both interstitial (as in the tongue), one field interstitial and one on a distance mould (as used for some surface growths, such as the breast or thick cheek lesions) or as bilateral moulds for extensive growths of the external auricle or external nose. Especially is this method useful when multiple and often oblique surfaces are involved. This is well illustrated by Case I.

Figure I. Case I. Showing patient before treatment.

Figure II. Case I. Showing patient before treatment.

Dosage is worked out mathematically in γ "*r*" units, and plotted every half centimetre each way; and all the factors in dosage (area, distance, filtration, time and quantum of radium or radon) are so arranged that the summated dose is almost constant throughout the whole thickness of treated tissues. The advantages of this are manifest. To illustrate this in crude figures, the summated dose in 1,000 *r* units would run something as follows, when plotted every half centimetre for a lesion of 2·5 centimetres thickness:

5 4 3 2 1
1 2 3 4 5

6 6 6 6 6

Expressed in *r* units, this means that all the tissues between radio-active fields so arranged would receive 6,000 *r*.

[1] Accepted for publication on October 13, 1941.

Case I.

H.A., aged seventy-four years, suffered for twenty-six years from basal celled carcinoma of the nose, which was treated first in 1915. In spite of innumerable treatments by futile methods (the application of carbon dioxide snow and radium plaques), this progressed steadily until September, 1940, when the patient presented a very extensive basal celled carcinoma involving most of the left side of the nose right up to the inner canthus, about half the right side of the nose and parts of the septum, vestibule and columella, with extensive destruction of the left *ala nasi*. Cartilage was extensively involved, and the growth was adherent to the nasal bones. Multiple surfaces and large areas were involved (see Figures I and II). An aluminium capsule, closely fitting the contours of the cheeks and extending right up to the supraorbital regions, was made in order to house the radio-active moulds and to maintain two essentials for success—exact distance and strict parallelism. These capsules have to be made to fit each individual and very carefully mounted and fixed to the patient. The eyes are protected by three millimetres of lead and rubber, and are sealed by bandages for the duration of the treatment, which in this case was 192 hours (see Figure III).

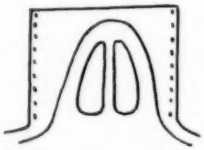

FIGURE III. Case I. Sketch illustrating method of mounting radio-active mould inside aluminium capsule.

Reaction was severe and lasted about three months, but the eyes were almost entirely spared, owing to the special protection. Photographs taken four months apart illustrate the effectiveness of the treatment better than any description; but, briefly, all signs of growth have disappeared, complete healing has occurred, appearance is excellent, and the psychological recovery in an old lady of seventy-four years is astounding. The only blemish is the partial destruction of the left *ala nasi*, which is well illustrated in Figures IV and V. At the time of writing, twelve months have elapsed since treatment, and the result is excellent.

FIGURE IV. Case I. Showing patient four months after treatment.

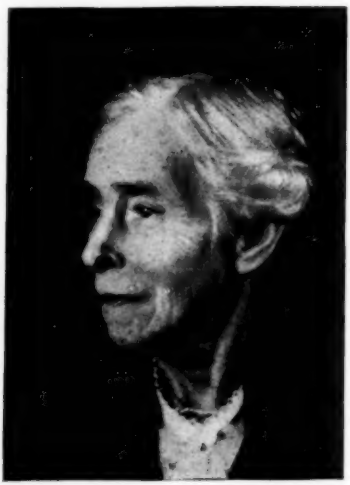

FIGURE V. Case I. Showing patient four months after treatment.

Case II.

A male patient, aged sixty years, suffered for two years from a growth in the right nasal vestibule; it was growing steadily, and had grown more rapidly recently. A misleading biopsy unfortunately put his medical adviser off the track for a long period. He presented a large very firm growth, with some crusting but very little ulceration, occupying most of the right vestibule of the nose, and extending upwards and backwards about three-quarters of an inch. Biopsy revealed squamous celled carcinoma.

This patient was treated in similar fashion to the patient in Case I, the only difference being in the extent of the area treated and in consequence the size of the moulds. The average dose was 6,300 *r*.

The result is as perfect as it is possible to imagine, as nothing abnormal is to be seen or felt on examination, and it is impossible to determine on which side the growth existed. This case did not lend itself to photography. Twelve months have passed since treatment.

Case III.

A male patient, aged fifty-nine years, presented a very extensive, painful and hæmorrhagic growth of the naso-pharynx. Obstruction of the posterior nares had been complete for several months. The growth could be seen directly by raising the soft palate. Biopsy revealed "transitional celled carcinoma". This case presented unusual and very difficult problems of dosage and distribution. It was obviously impossible to implant the growth, as it was very soft and hæmorrhagic, and accurate distribution under the anatomical conditions was impossible. The distances involved made it futile to use a single field of radium or radon, and the problem was how to bring two radio-active fields to bear on the growth.

As sterile interstitial moulds had been used with marked success in other areas where it was impossible to place and distribute needles or seeds accurately, it was determined to use the post-narial region for an ordinary mould, made of lead and loaded with 18 milligrammes of radium, and to place a sterile interstitial mould in the retro-pharyngeal space. Firstly, the lead mould was made of three millimetres of lead knurled over at the edges, so that the radium needles could be fixed into the mould with wax. This mould was placed against the posterior nares, and securing threads were brought out through the anterior nares and tied over rubber (see Figure VI). It contained 18 milligrammes of radium, and three milligrammes of lead filtration was provided to prevent heavy dosage to the tissues immediately anterior to the mould. This mould was also enclosed in rubber. The retro-pharyngeal mould was made of stent under sterile conditions. There is apparently no plastic material which can be made up and then boiled.

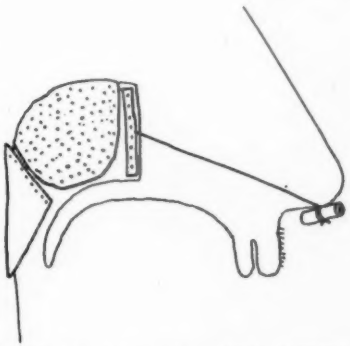

FIGURE VI. Case III. Sketch showing position of moulds.

It was a double inclined plane with the radium (19 milligrammes) mounted on the upper surface. All measurements for these moulds were taken from a number of skulls and cadavers and averaged. There was not much variation, and for purposes of working out dosage and plotting summated dose every half centimetre, it was essential to be very close to exact measurements, yet it was practically impossible to take measurements on the individual concerned.

It was not possible to place moulds that would irradiate this growth from two parallel fields, so that a rather difficult oblique summation of dose had to be worked out. This gave an approximate 6,000 *r* throughout the tumour.

An incision was made anterior to the upper right sterno-mastoid muscle and the retro-pharyngeal space was opened up. The mould was introduced and pushed right up to the pharyngeal tubercle, and a few stitches were placed to maintain it in position; the wound was completely closed. Both moulds were removed 168 hours later. A little sterile pus (really "laudable") had collected, as always happens, around these sterile moulds. This was swabbed out, and the wound was closed without drainage. It healed by first intention.

Reaction was fairly severe, but hæmorrhage ceased almost immediately, and the growth rapidly and completely disappeared. The only departure from normal since then has been slight but persistent crusting over a small area of the roof of the naso-pharynx. This causes no symptoms.

The patient has remained well and no secondary deposits have appeared. He has been under frequent supervision, and it is now four years since treatment.

Surgery in Other Countries.

[In this column will be published short résumés of articles likely to be of practical value from Journals published in other countries and not readily accessible to surgeons in Australia and New Zealand.]

POST-OPERATIVE TETANY.

E. Åkerberg (Örebro): "*Die Behandlung der postoperative Tetanie*", *Acta Chirurgica Scandinavica*, Volume lxxxii, 1939, page 413.

ÅKERBERG's article is a long and interesting essay on post-operative tetany, of which the most interesting portions deal with the blood chemistry and the modern methods of treatment. It must suffer considerably from the compression necessary in such an abstract as this; but the original is written in an easy fluent German, and anyone who has any slight knowledge of that language would do well to read it.

Only two cases occurred at Örebro among 172 patients submitted to thyreoidectomy, which is lower than many of the published figures. The author points out, however, that with the recent adoption of the operation of total thyreoidectomy for uncompensated heart diseases, the frequency of this complication is likely to increase. It has lost many of its terrors, fortunately, since in the last decade our therapeutic armament has been "almost ideally" strengthened by the new absorbable calcium preparations, the perfection of parathyreoid extracts, the new method of gland transplantation, the extraordinary substance known as "A-T 10", and lastly perhaps by Oppel's interesting method of implantation of bone substance.

The underlying essential condition in the production of tetany is a lowering of the calcium content in the blood, whereby muscle irritability, normally held in check by calcium, is allowed to increase. Tetany supervenes as a rule when the blood calcium level falls to five to seven milligrammes *per centum*. As a practical guide, however, this reading is often unreliable because of the three forms in which calcium exists in the body tissues, namely as free ionized calcium, in combination with blood proteins, and in an uncomprehended combination spoken of as "combined calcium X"; only the first, the free calcium, is able to produce the "calcium ion" effect. The relation between the free and the combined calcium is maintained within very narrow limits by the parathyreoid hormone, which controls the "sluice" by which calcium is withdrawn from the massive skeletal depot which, in an adult, contains about two to three kilograms of pure calcium. Only about a thousandth part of this amount is normally to be found in the blood and the tissue fluids, and of this quantity the free calcium varies in health between four and five milligrammes per 100 cubic centimetres. With the parathyreoids overacting, this may rise to six to eight milligrammes, and in parathyreoid deficiency it may drop to one to two milligrammes. Calcium salts in the blood exist normally in a saturated solution, and should the parathyreoid overfunction and open the "sluice" too widely, the surplus must be excreted. This takes place mainly by the bowel, and to a less extent through the kidneys, and occasionally it results in the formation of calculi. If on the other hand the parathyreoids fail to maintain the necessary stream of calcium from the bony depots to the body fluids, this failure must be made good by parathyreoid extract or by "A-T 10". By laboratory estimations of the total blood calcium level it is impossible to distinguish the amount of "free" calcium present, the varying proportions of which explain those cases in which tetany does or does not arise when blood calcium estimations would indicate that it should not or should. Recently the biological chemists have been devoting more attention to the relation of the phosphorus content in the blood, in relation to parathyreoid failure, and it is now considered likely that alterations in the blood phosphorus are the primary phenomenon and those in blood calcium secondary to this. The blood calcium level does not show the rhythmic variations seen in the case of the blood sugar. It is held approximately constant by the parathyreoids, which also regulate the relationship between free and combined calcium.

As regards prognosis, one-third of the patients with post-operative tetany who are not treated may be expected to die of it. Of the remaining two-thirds, some will recover spontaneously, the others pass into a state of "latent tetany". This latter group can adjust themselves fairly well to a lowered blood-calcium level. Some among them live manifestly on the border-line of tetanic attacks. Their muscles are rigid, they move with difficulty, and are evidently invalids. Others have a relatively bearable life; but their latent tetany manifests itself when they come under bodily strain, such as muscular effort, infections, menstruation, or pregnancy. Even without these, however, they are not well, and symptoms varying from cachexia and depression to cataract and

dermatitis herpetiformis are found among them. They show a heightened muscular irritability and a "lightning" facial reflex. The question of prognosis assumes great importance in these people. Can their bodies, with the passage of time, enrich the calcium content of their blood unaided? Or must they come under permanent treatment? In general Åkerberg's conclusion is that they should be brought under treatment; and in the new substance "A-T 10" we have the most suitable agent.

In the matter of treatment the exhibition of calcium salts to such patients needs in these days no emphasis. Intravenous injections of suitable solutions are a sovereign and adequate remedy for the acute attacks, and swiftly raise the lowered blood-calcium level. The various preparations for oral use are of a greatly differing value. Calcium carbonate, phosphate and lactate when given by mouth have no effect on the calcium level in the blood. Calcium chloride and gluconate, on the other hand, are effective, cheap and easily absorbed. Vitamin *D* is also a valuable aid. Even without simultaneous administration of calcium salts it can of itself greatly raise the blood-calcium level; and when it is given with these salts the amount of calcium needed is greatly lessened. Parathyreoid extract loses its effectiveness if given in the presence of vitamin *D* deficiency. The effect of blood acidity on the calcium values is also of importance. It is known that spasmophilia and tetanic cramps are concomitants of alkalosis, while in a condition of acidosis a stream of calcium is drawn from the skeletal depots into the body fluids. In this respect, and bearing in mind the close connexion between the calcium and the phosphorus content of the blood, wherein when the one rises the other falls, one would plan a diet rich in acid properties and avoid food containing much phosphorus.

Transplantation of the parathyreoid glands in the past has been of little permanent value, owing to the demonstrated fact that the glands are absorbed entirely within twelve months. But recent work in America by Stone, Owings and others makes the prospect better. They have taken parathyreoid glands from babies and young children, and cultured them for four weeks in a medium impregnated with serum from the expectant recipient. Thereafter in small fragments they are implanted in suitable situations in the recipient, and in such cases animal experiments have shown that the grafts were vital and active in parathyreoid properties when removed a year and more later. These workers have also reported full clinical success in several cases in man. Preparations of parathyreoid hormone, though useless when given by mouth, when given parenterally have a value comparable to that of insulin. Their use is preeminently suited for acute attacks. Like insulin, parathyreoid hormone must be given in frequent doses and it is at present costly, approximating 15s. each dose.

"A-T 10" has almost entirely supplanted the use of parathyreoid extract in recent years, and a literature has grown up around this substance which, Åkerberg holds, makes one wonder whether post-operative tetany is really as rare as was thought. It is not a hormone and not a vitamin in the usual sense of the term, but is a derivative of the antirhachitic vitamin *D*. If ergosterin is irradiated with ultra-violet light a substance is formed which has a very strong calcium-mobilizing effect. The pure preparation of this factor in oil is maufactured and sold under the name "A-T 10". Holz explains its action thus: first it increases the absorption of calcium by the bowel; and, secondly, it has, as has the parathyreoid hormone, the power of mobilizing the skeletal calcium reserves without causing acidosis. It acts best when given by mouth, less effectively when injected. The effect is not evident for some days after administration, but is so long-lasting that it can be used in a fairly large dose once a week. It is so efficient that there is a distinct danger of producing renal calculi by overdosage. Its advantages over parathyreoid extract are that it is cheaper, is easily absorbed from the bowel, need not be injected, is stable, and can be kept without loss of efficiency. Its effects last longer, and the danger of overdosage is not so great. When it was first introduced urgent warnings were issued about the possible ill effects of overdosage; but with the present much purer preparation these are not greatly to be feared when ordinary care is used. Should hypercalcæmia occur, ovarian follicular extract is said to be a specific antidote. Eight cubic centimetres given by mouth should raise the blood-calcium level by about two to three milligrammes *per centum*, although in some resistant cases more is required. Once the position is stabilized it is not necessary to repeat the estimations of the blood calcium oftener than once a month.

The modern treatment of a patient with post-operative tetany therefore would be along these lines. At the first onset give calcium intravenously, with two cubic centimetres of parathyreoid extract ("Parathormone"), and at the same time start the exhibition of suitable preparations of calcium by mouth, and administer five cubic centimetres of "A-T 10" every three or four days. For the first day or two, until the "A-T 10" has had time to act, intravenous administration of calcium and parathyreoid extract must be continued. The blood calcium content must be estimated every two days or so for the first week. Further treatment will be with "A-T 10", which may be given either as one cubic centimetre daily or five to seven cubic centimetres once each week. The optimum dosage will soon be determined. It may well be necessary in the treatment of female patients to give an extra two to three cubic centimetres in the

premenstrual period. The one drawback to which this substance is subject at present would appear to be its price. Though less expensive than "Parathormone", to keep a patient going on a dose of five cubic centimetres weekly would cost about £25 *per annum*.

The final modern method of treatment of these cases is the implantation of bone grafts in the musculature of the patient to provide him with a further reservoir of absorbable calcium. Sterilized bone or "*os purum*" is used. How it acts is not explained so far, and in many cases the implantation has been made so early that any subsequent improvement might well be attributable to the power of spontaneous recovery noted in so many patients. But in some cases, including one reported and discussed by Åkerberg, its effect appears to be undoubted. Åkerberg sums up this subject by remarking that it is easy and harmless and may well do good.

ARTHUR E. BROWN.

TOTAL EXTIRPATION OF THE PATELLA.

Stern Friberg (Stockholm): "*Über Totalextirpationen der Patella*", *Acta Chirurgica Scandinavica*, Volume lxxxv, 1941, page 361.

THE operation which is usually undertaken in Sweden for the degenerative changes in the patellar cartilage known under the name of chondromalacia, is excision of the diseased cartilage; and it often gives very satisfactory results. In the severer grades of the disease, however, in which the cartilage is eroded entirely off the bone surface, this operation is not feasible, and in the past the technique for these cases has been the removal of the posterior part of the patella itself, the reconstituting by various plastic procedures of a fresh gliding surface and the utilization for the purpose of one or other of the various soft tissues available. Good results can be obtained by this operation, but the time needed for achieving them is a very long one. On the other hand, by excision of the patella itself altogether, which has been the operation of choice for some years at the Caroliner Hospital in Stockholm, equally good results can be obtained in a very much shorter time.

Friberg now presents a series of 32 such excisions for review. The indications have mainly been chondromalacia, with in addition some stiff knees following old fractures. No cases of recent fracture of the patella are included in the series, though Friberg recognizes that when comminution is present the indication may exist. The 32 excisions were done in 30 patients. Twenty-three were performed on account of chondromalacia, eight for stiff knee joints following fractures of the patella or femur, and one in a post-gonorrhœal knee. In the fracture cases, changes in the patella cartilage were the immediate factor in causing the disability; but as the joint itself was not normal, the resulting freedom of movement was not so great as in the cases of chondromalacia. Almost all the patients had had a prolonged trial of physiotherapy prior to coming to operation; and most of them had been crippled for varying periods of time.

The operation is performed under spinal anæsthesia and with a tourniquet placed as high up on the thigh as possible, this being important so as not to interfere with the drawing down of the quadriceps tendon for suture. Longitudinal incisions, five to eight centimetres long, were made in the mid-line of the knee through both skin and tendon. The patella is enucleated with a knife, for if a raspatory is used, bone splinters are likely to be left behind; and these later form a bony nodule which can give rise to future trouble. It is necessary to be careful not to damage the prepatella tendon, for in some cases, such as old fractures with wide separation of the patellar fragments, it may be impossible to draw down the quadriceps tendon to the patellar ligament, and the power of extension will in those cases depend solely on these tendons. In fracture cases too adhesions between the patella and the femur must be carefully separated. In two of Friberg's cases adhesions obliterating the subcrural bursa had to be dealt with before the quadriceps tendon could be properly brought down. In one of these two the adhesions reformed and were responsible for the relatively poor result obtained. When brought down, the deep surface of the quadriceps tendon is sutured to the patellar ligament with two heavy mattress sutures of catgut. The superficial surface is sutured similarly with two mattress sutures of silk. Medially and laterally it is wise to exercise great care in the suturing of the two structures, so that there is no contact between the patellar bed and the knee joint. This is a precaution against future trouble arising in the event of new bone being formed in the patellar bed.

For the first day or two after the operation the patient wears an elastic bandage from foot to groin, and it has been very rare for any hæmatoma to form. On the third to fifth day a plaster bandage was put on, in which the patient could stand or walk without pain. Movements were commenced some ten days later and were at first limited to active quadriceps contraction; the patient was generally ready for discharge from hospital in about five weeks. The average time in which these patients were able to resume their work was two and a half months.

In judging the results of the operation at a later stage, those patients who could do their full work, engage in sport and rely on their knees for any strain, were graded as Class I. Of these there were 13.

Those who could do their usual work easily, but noticed pain or lack of power in more severe stress or in sporting activities, were put in Class II; and there were 14 of them.

The patients who in doing their normal work complained of some loss of power, and had intermittent hydrops and some crepitus, were graded Class III. Five patients were so graded. There were no patients in a lower grade of result than this. The first two grades comprised 84% of the patients treated, and these expressed themselves as thoroughly well satisfied with the results. Even the appearance of the knee was very little altered when the quadriceps tendon was well sutured to the patellar ligament.

The principal functional test of the success of the operation is the obtaining of the power of full extension; and this was nearly always achieved. In only two cases was a diminution seen. Muscle power in extension was, however, diminished in some degree in most cases; the diminution corresponded roughly in degree to the diminution in thigh circumference, indicating quadriceps atrophy as compared with the unoperated limb. In no fewer than 26 of the patients late X-ray examination revealed shadows of calcification indicating some attempt at regeneration of the patella. The grossest of these caused crepitation and some pain; but most of them were minor and caused no trouble.

The operation is not to be recommended as a routine in all cases. Many patients do not need it. Others are cured by the simple removal of the cartilage. Some are so badly affected as to be beyond help from any surgical procedure. When the operation is done, however, and done with care, and when the cooperation of the patient is secured in the after-treatment, the results can be astonishingly good.

ARTHUR E. BROWN.

POST-OPERATIVE THROMBOSIS.

G. Bergquist (Lidköping): *"Über postoperative Thrombosen"*, *Acta Chirurgica Scandinavica*, Volume lxxxiii, 1940, page 415.

BERGQUIST opens his article with a preliminary discussion of the theories concerning the production of post-operative venous thrombosis. The thrombi consist of the main "agglutination" thrombus made up of platelets, leucocytes and fibrin, and an accessory portion, the "coagulation" thrombus, in which all the blood elements are present in approximately their normal proportions. The formation of a thrombus does not, therefore, depend solely on the process of coagulation, but also on changes in the conditions of the actual blood stream. It may be due, as Aschoff suggests, to the existence of "eddys" in the stream, acting much in the same manner as those which cause sandbank formation in shallow rivers. There has been considerable research and discussion as to the relative importance of the three causative factors in thrombus formation, namely changes in blood composition, damage to vessel endothelium and conditions of blood flow. This is necessary, because since treatment of established thrombosis is admittedly discouraging, any hope for the improvement of results must lie in some better method of preventing its occurrence. On this basis, Bergquist proceeds to his main thesis, the use of heparin. Heparin is an anticoagulant, which acts in the earliest stages of the process in the sense of an "anti-prothrombin". To be effective therefore it must be used before this stage of thrombus formation occurs. Many authors testify to its value in reducing the incidence of post-operative thrombosis, and as a result it has been urged that it should be given in intravenous doses of 50 to 100 milligrammes every four hours to all patients. Such action, however, would be laborious, costly and in many cases unnecessary and even meddlesome; and Bergquist has endeavoured to find some standard by which the advisability of using it in any individual may be determined.

In seeking this he turns to the coagulation time, and he has made a series of tests of patients in a post-operative state to study the changes in the coagulation time and the number of platelets. The latter he finds to show no significant change at all and has discarded it. The coagulation time, however, he finds to follow a regular curve of diminution and recovery, the maximum diminution (the minimum time) being between the fifth and eighth days after the operation. He describes the performance of the test he uses thus: "With a needle boiled in distilled water, and a clean 'Record' syringe, blood is drawn from a distended arm vein, and three drops are allowed to fall into a well cleaned watch-glass. The endpoint is taken when rotation of the vertically held glass fails to produce any alteration in the shape and size of the blood drops, discernible in good daylight." The normal time by this method varies from three to five minutes.

The total number of patients suffering from post-operative thrombosis at Lidköping in the decade 1929-1938 are charted by Bergquist as to both the day on which the

thrombosis occurred and the coagulation time, and there is an evident correspondence between the minimum coagulation time and the thrombosis. In cases in which thrombosis did not cause symptoms in less than fifteen days, the influence of the operative procedure on its production is taken as being remote, and other factors are considered as being more definitely responsible. Of the 91 patients tabulated graphically, 43, or nearly half, suffered from pulmonary embolism. Whether from absorption from the operation area, or from changes in the circulatory conditions, or from whatever reason, a diminution in the coagulation time occurs in these cases in which circumstances are favourable to the development of agglutination thrombi. In younger people, and in operations of lesser severity, these changes do not last long enough for the danger of thrombosis to be very great. But should the condition last long enough—say, twelve hours or more—a thrombus will form.

If this reasoning holds good, a prethrombotic state should be recognizable in these people, and the condition ought to be susceptible to treatment by heparin. Applying this principle to the succeeding four patients whose blood coagulation time fell below three minutes, Bergquist treated two of them with heparin and the other two by the previously used routine methods. The two who received heparin showed no signs whatever of any thrombus formation, but in both of the other two thrombosis occurred, one of them developing a fatal pulmonary embolism. He therefore decided to carry out investigation and treatment in all future post-operative cases as a routine. So soon as the coagulation time is found to be less than three minutes, 0·6 cubic centimetre of a 5% heparin solution is injected, this dose being sufficent to control the coagulation time for four hours. At the end of this period it is reestimated and if it has not returned to at least a normal level, one cubic centimetre is given and the coagulation time is then reexamined after six hours. If it is still unsatisfactory, a further two cubic centimetres are given and the coagulation time is estimated after seven or eight hours. No injection additional to this series has ever been found to be necessary.

Many authors have considered that for full protection against the danger of thrombosis the coagulation time should be raised to three or four times its normal level, but Bergquist is of the contrary opinion. So long as it is maintained at approximately its normal the patient is apparently safe. A series of fifty cases in which this treatment was adopted, is reported. From it all lesser procedures such as hernia repair and appendicectomy in young people have been excluded. In eight of these fifty the coagulation time fell to levels at which the administration of heparin was advisable, and in none of them was any formation of thrombi seen. This necessarily means little, and Bergquist puts forward his paper as a preliminary report of an encouraging nature in the hope that further series by other observers will be available along with later series of his own, which it is hoped will supply sufficient material on which to base a valid opinion as to the value of the method.

It appears to be an entirely safe one. The heparin may be given either into a vein or subcutaneously or intramuscularly. If given by either of the two last-mentioned routes one must expect the formation of a painful hæmatoma, which takes some four or five days to be absorbed. Therefore it is given by preference into a vein. But should this intravenous route be difficult or inconvenient, subcutaneous or intramuscular injection may be undertaken without hesitation.

ARTHUR E. BROWN.

Reviews.

Roentgen Treatment of Infections. By J. F. KELLY, M.D., F.A.C.R., with the collaboration of D. A. DOWELL, M.D.; 1942. Chicago: The Year Book Publishers, Incorporated. Medium 8vo, pp. 432, with 122 illustrations. Price: $6.00 net.

KELLY AND DOWELL have produced a volume on the treatment of infective processes by X-ray therapy. The appearance of the book is timely at this stage when the importance of the subject is being more widely recognized.

The first part of the book does scant justice to the fundamental physical basis of X-ray therapy. The presentation is inadequate for the needs of the practising radiotherapist, and a practitioner with no prior knowledge of the subject would be confused. The authors are inviting trouble when they state: "The particular field of roentgen therapy under discussion is the simplest and safest and the only type of roentgen therapy one is justified in attempting without special training in radiology" (page 58). A page or two later (page 60) is found: "For one not accustomed to giving X-ray therapy we recommend the following procedure . . . ", and a technique is detailed for use with an uncalibrated fluoroscopic unit. The danger of using an uncalibrated diagnostic machine for therapeutic purposes cannot be too strongly emphasized. Particularly in this section the reader is annoyed by numerous examples of bad composition. A typographical transposition is found on page 46.

The major part of the book is devoted to gas gangrene infections. The authors' thesis may be summarized as follows. Surgery alone has produced a mortality not less than 40% to 45%. These figures have improved consequent upon the use of anti-gas serum, but X-ray therapy has reduced the mortality to 11·5% in 364 cases of traumatic gas infections. These results have changed the rôle of surgery in the disease. No justification is held to exist for amputation as a therapeutic measure; and immediate surgery should be limited to the removal of obviously dead or disorganized tissue, incisions for the relief of tension and drainage. The sparing of gas-infected tissues allows much recovery under X-radiation, and ultimate tissue loss is minimized. Amputation should be carried out only as an initial proceeding if the limb is disorganized or its blood supply cut off. X-ray therapy is given two or three times daily for three days or more, and causes an immediate relief of toxæmia, inhibition of further spread and local improvement.

The authors have presented enough material to justify their contention; and though it is very difficult to agree with many of their statements, the principles enunciated can be well appreciated. It is not too much to say that a new era in the treatment of these infections has commenced, and the credit for this goes to Kelly. However, the work needs severe editing to eliminate much tiresome "propaganda" for the treatment method advocated, and the unending repetition of statement is irritating.

One cannot agree that "usually any injury warranting tetanus antitoxin should receive X-ray prophylaxis for gas infection" (page 135); nor does there appear to be any logic in the statement that "in advanced cases some [X-ray] treatment might well be given over distant important viscera, the heart, liver, kidneys . . . which are badly damaged by the toxins of the gas forming group. . ." (page 179).

Unfortunately the presentation of the whole section on gas gangrene is not in the tradition of a first-class scientific monograph, and the authors' cause may suffer in consequence.

In the latter part of the book new ground is broken in the advocacy of X-ray therapy for certain types of spreading peritonitis. Impressive radiographs of pneumonic conditions before and after treatment are reproduced, and the beneficial effects of radiation in the various stages of pneumonia are considered. The concluding chapters deal with the radiation treatment of such lesions as surgical parotitis, boils and carbuncles—a field where the useful effects of X-ray therapy are being more widely recognized.

Diseases of the Nervous System Described for Practitioners and Students. By F. M. R. WALSHE, O.B.E., M.D., D.Sc., F.R.C.P.; Second Edition; 1941. Edinburgh: E. and S. Livingstone. Demy 8vo, pp. 341, with illustrations and diagrams. Price: 12s. 6d. net.

As an introduction to the science and art of neurology Dr. Walshe's book is unsurpassed. The clinical features of the common neurological disorders are lucidly and concisely displayed. A lively and impressive style, few but well chosen illustrations, clear reproduction and type materially assist the reader. Of special interest and value are the statements on ætiology and treatment. The author has taken special care to examine critically claims made in these fields, supporting his conclusions with precise, sound and scientific argument. Discussing subjects upon which there is a great difference of opinion—for example, the ætiology of compensation neurosis and nocturnal enuresis of childhood—Dr. Walshe justifies his own views with convincing reasoning inviting further consideration of opposing views. Excellent opening chapters on fundamental neurological anatomy and physiology and basic factors in diagnosis pave the way for the appreciation of the general part of the work, which is permeated with the artful advice of a wise physician.

Age Morphology of Primary Tubercles. By H. C. SWEANY, M.D.; 1941. Illinois: C. C. Thomas. London: Baillière, Tindall and Cox. Royal 8vo, pp. 280, with 75 illustrations. Price: $5.00.

H. C. SWEANY is Medical Director of Research at the Municipal Tuberculosis Sanitarium, Chicago; his book is an excellent and instructive monograph. The author postulates the theory that the age morphology of primary tubercles can, by careful observation both of the pathological changes and radiological appearances, be determined with reasonable accuracy.

He quotes the well-known time factor in the relationship between the symptoms and pathological changes in typhoid fever and pneumonia, and applies this factor to tuberculosis. Owing to certain difficulties, too extensive and too small lesions are eliminated from this study, and only lesions of a range of from three to twelve millimetres in diameter are considered. The ageing characteristics of these lesions are found to change at a more or less regular rate. The morphological changes have been found to be roughly similar within definite age periods.

The earlier portion of the monograph consists of a clinical and pathological study of one hundred cases in which contact occurred before the patients were seven years of age. A definite relationship was shown to exist between the age of the primary tubercles and their physical appearances in this group.

Encouraged by the consistency in the findings of the first group, the author investigated a further group of one hundred patients having an accurate history of contact at any time during life. The result of this is shown in an "age spectrum" chart, which gives a graphic description of the progression of the changes that tubercles undergo as they advance in age. Considerable space is given to the radiological aspect and an attempt is made to link up the pathological time progression with radiological appearances. One of the uses of this "age morphology" system is demonstrated in placing the time of infection in a group of nurses and hospital attendants. No claim is made that the system is infallible, but useful facts are presented which should stimulate further investigation. With such investigation the usefulness of the age morphology hypothesis of primary tubercles in the realm of repatriation, and medico-legal problems could be determined.

This book should be of especial interest to those who have followed the results so far obtained in the mass radiography of recruits to the Australian Imperial Force and the work of Reginald Webster on the culture of tubercle bacilli from the fasting gastric contents of those recruits whose skiagrams are under suspicion.

Acute Injuries of the Head: Their Diagnosis, Treatment, Complications and Sequels. By G. F. ROWBOTHAM, B.Sc., F.R.C.S.; 1942. Edinburgh: E. and S. Livingstone. Crown 4to, pp. 300, with 124 illustrations. Price: 25s. net.

MR. ROWBOTHAM'S textbook arrives at a most appropriate time, following a long silent period in the literature of acute head injuries. As a neurological surgeon of Geoffrey Jefferson's school, he may be regarded as an authority on this subject. The scope of the text is considerable, and the author deals in an original manner with such widely separated problems as the mechanics of cerebral trauma, current theories of cerebral concussion and electroencephalography in the investigation of post-traumatic states. The whole subject has been included in two hundred and seventy-seven pages of well illustrated text matter and forms an excellent reference manual for those who have had little special neurosurgical training. This is particularly true of the section on surgical technique, and army and air force medical officers, posted to operational areas, will find it of great value.

With many details of theory and practice, some difference of opinion will obtain amongst other specialists in this field; but, with perhaps one exception, these do not reduce the merit of a publication of this character which must necessarily represent the author's background and personal experience. However, the early use of morphine (grain one-quarter, page 112) to control restlessness is quite contrary to current practice, at least in this country. This drug is known to increase intracranial pressure, has a selective depressant action on the respiratory centre, may mask impending stupor and not infrequently excites the patient further. It offers nothing which cannot be obtained by paraldehyde given *per rectum* or "Dial" given parenterally. Mr. Rowbotham qualifies the position by stating that drugs are better withheld, and with this view general agreement will be found.

The book is excellent and should find a place in every practitioner's library.

The Injured Back and its Treatment. Edited by JOHN D. ELLIS, M.D.; 1940. London: Baillière, Tindall and Cox. Crown 4to, pp. 385, with 157 illustrations. Price: 30s. net.

THE editor states in the foreword that the purpose of the work is mainly diagnostic and therapeutic. A mass of valuable instructive information is contained within the 365 pages, even if it is possible at times to see another angle to the problem.

The book consists of ten articles, each of which deals with a different aspect of the subject and is complete within itself.

Professor Keith presents the modern theory of man's posture by a summary of the evolutionary changes in the spines of primates, and shows that function determines anatomical structure.

In an excellent article illustrated by charts and diagrams Professor Nathan Davis gives a clear exposition of the segmental origin of backache from various diseases of thoracic and abdominal organs.

Compression fracture of vertebræ is presented by Dr. Conwell from his personal experience of a large number of cases. The discussion on clinical examination and diagnosis is excellent. Reduction is effected by a special type of hyperextension frame; the traction method of Davis is described, but the simpler Watson Jones method is referred to in an editor's note. Tables of 100 cases are presented, but periods of disability and final results are not given.

Dr. Loyal Davis, in a very readable, common-sense article, deals with the neuro-surgical aspect of cord injuries. His discussion on diagnosis, operation and after-care of paralysed muscles is lucid and interesting.

Body posture and its effect on health, strained back and late results of fracture are discussed by Dr. Osgood. He presents an aspect of the injured back which is often disregarded.

The other articles in the book are devoted mainly to the lumbar region of the spine. Dr. Ralph Ghormly, in a very interesting and valuable contribution, deals with lesions of the articular facets, their diagnosis and treatment. His discussion on this is brief and to the point.

The contributions of the editor, Dr. John D. Ellis, are probably the three most valuable chapters in the book. His views on the method of examination, clinical manifestations and diagnosis on low back pain are very instructive. He presents a comprehensive survey of the relationship of trauma to anomalies and disease of the spine; the discussion is sound and interesting, and the reader cannot help but admire the result and feel grateful to the author for the amount of work entailed in its production. The final chapter deals with the treatment of minor injuries to the back, the varied physiotherapeutic procedures for muscle and joint injuries, and operative measures for more severe lesions, such as spondylolisthesis and disc herniation, are discussed at some length.

The book is readable and instructive, and the subject in each article is presented in an authoritative manner. The extensive bibliography makes it valuable for purposes of reference.

The 1941 Year Book of Industrial and Orthopedic Surgery. Edited by C. F. PAINTER; 1941. Chicago: The Year Book Publishers, Incorporated. Crown 8vo, pp. 432, with 353 illustrations. Price: $3.00 net.

ALTOGETHER this précis is excellent and the standard that was so highly commended in the review published in this journal last year has been more than maintained. The selected illustrations and the extracts of papers published in America and other countries have been chosen with eclecticism. The publishers have not exaggerated when they state "the man who relies on the 'Year Book' to keep abreast of progress may be sure he is missing nothing of first-rate importance". In a subject like orthopædic surgery where operative procedures are not standardized and more than one operation can be used for correction of an orthopædic disability, the recent literature provides a guide to the general surgeon in the selection of the appropriate operation. Special attention is given to sciatica caused by retropulsion of the lumbar intervertebral discs as distinct from "ordinary" sciatica, painful feet and osteoarthritis of the spine. Throughout the book descriptions and illustrations of surgical technique abound, although the book is small and inexpensive.

A Text-Book of Surgical Pathology. By C. F. W. ILLINGWORTH, M.D., Ch.M., F.R.C.S., and B. M. DICK, M.B., F.R.C.S.; Fourth Edition; 1941. London: J. and A. Churchill Limited. Medium 8vo, pp. 736, with 300 illustrations. Price: 38s. net.

THE appearance of the fourth edition of this work in ten years is at once evidence of the demand for such a compendium and proof of its success in meeting that demand. Such books are necessarily a compromise between the more general textbooks and encyclopædic works of reference, and demand of their authors judicious selection, balance in treatment, clarity of presentation and beauty of illustration. They must avoid both superficiality and prolixity and yet adequately present current thought. There can be no complaint about frequency of editions, therefore, since this but reflects the necessity for frequent review if teaching is to keep a sufficiently kinematic eye on the panorama of developing knowledge and changing views.

The authors have shown a wise restraint in meeting the temptation to expansion that besets compilers of textbooks. Within the limits set they have succeeded passing well in producing a book that provides a useful starting point and guide to the study of those pathological conditions which are of special interest to the aspirant surgeon. Its popularity is the answer, justly formidable, to any general criticism.

Though such compilations make no pretence to add to surgical or pathological knowledge, are inclined to have somewhat the air of a catalogue and are apt in consequence to be uninspiring, they play no small part in promulgating views. The authors assume a serious responsibility, and the more popular their work, the greater the influence of their dicta and the graver that responsibility.

Since selection implies omission, critics have a large target. If, for example, it be considered that glandular enlargement in syphilis is conceivably too out of date for inclusion, the influence of bone injury in the development of gas gangrene may be possibly too modern. The pericardium is of considerable surgical interest, but receives no mention.

Space limits the usefulness of the gynæcological section, but is not wholly responsible for a certain disappointment with the matter presented on, for example, the nature of "chronic endometritis" and cervical erosion. The treatment of "secondary toxic goitre" is rather sketchy for so important a subject, and the malignant possibilities of carcinoid tumours of the appendix are too lightly touched. The fact that air embolism may occur during blood and other transfusions is perhaps worth mentioning now that such procedures are so frequent.

To stress criticism of detail is to distract attention unfairly from the merits of the book. The new edition will establish the reputation of "Illingworth and Dick" more firmly than ever. Some proof-reading slips, such as "and tractable" for "intractable" (pages 39 and 174), "aglenoid foss" for "the glenoid fossa" (page 190), were noted in passing. The paper, printing and the admirable reproduction of the lavish illustrations are in keeping with the high standards always associated with the name of the publishers.

Encephalography (Monograph Number Two from the Walter and Eliza Hall Institute of Research in Pathology and Medicine, Melbourne). By E. GRAEME ROBERTSON, M.D., M.R.C.P., F.R.A.C.P.; 1941. Melbourne: Macmillan and Company Limited. Crown 4to, pp. 118, with 68 illustrations. Price: 25s.

IN this book on encephalography Dr. E. Graeme Robertson discusses the indications calling for the use of this aid to diagnosis and the contraindications, the technique involved in the introduction of air and the taking of skiagraphs, and the interpretation of the skiagraphs, normal and abnormal.

Dr. Robertson's methods are unusual and could have been perfected only by an enthusiast equipped with a deep knowledge of anatomy, physiology and pathology of the parts involved. The plan of taking serial skiagraphs during the actual introduction of air obviously has great advantages and largely eliminates the failures often attendant upon less painstaking methods; but it calls for patience and care in execution.

The chapter on the routes taken by the air is most instructive and valuable in that a knowledge of the behaviour of the gas enables the physician or surgeon to ensure at will adequate filling of any part of the liquor-containing spaces, unless some pathological condition interferes. Filling of the third and fourth ventricles appears to be particularly certain and complete.

Abnormal appearances produced by various pathological conditions are discussed and illustrated freely. The presentation of case notes in appropriate places adds to the value of the descriptions.

The book is well written, and the reproduction of the skiagraphs which give every evidence of a high degree of technical skill, is excellent. Line drawings are freely used to simplify a study of the skiagraphs.

The work is confidently recommended to the notice of neurologists, neurosurgeons and radiologists.

Diseases of the Nose, Throat and Ear: A Handbook for Students and Practitioners. By I. S. HALL, M.B., Ch.B., F.R.C.P.E., F.R.C.S.E.; Second Edition; 1941. Edinburgh: E. and S. Livingstone. Crown 8vo, pp. 462, with 74 illustrations and 4 coloured plates. Price: 15s. net.

THIS book is specifically designed for the information of the general practitioner and for the teaching of senior students. It will more than satisfy all the needs of the former and contains far more than the most industrious student is ever likely to absorb in the time at his disposal.

The arrangement and planning of the book could hardly be improved upon; particularly useful are the admirably illustrated, lucid and succinct anatomical sections which precede each major division of the subject under discussion.

The clinical teaching is in the best Edinburgh tradition—dogmatic, practical and not overloaded with detail. The description of surgical proceedings is, for a book of this size, and considering the audience to which it is addressed, too detailed. The pitfalls are not sufficiently stressed, and the facile text may tempt the unskilled or the unwary into a far too easy descent into Avernus. It is the patient and not the amateur surgeon who, for the rest of his life, rues the day he was operated upon. In point, detailed descriptions which encourage operations on the frontal sinus or the mastoid process by any but those adequately trained are to be deprecated, while all that should be said on the management of labyrinthitis is that the patient should be sent, with the utmost despatch, to the nearest base hospital where adequate neurological and surgical skill is available.

The illustrations are admirably chosen and their reproduction is excellent. Special mention must be made of the radiological plates; their significance cannot fail to be appreciated by the most inexperienced student.